





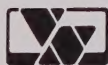
VALHALLA SCIENTIFIC, INC.

VALHALLA 2100/2101 DIGITAL POWER ANALYZER OPERATION MANUAL

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CERTIFICATION

Valhalla Scientific, Inc. certifies that this instrument was thoroughly tested and inspected and found to meet published specifications when shipped from the factory. Valhalla Scientific, Inc. further certifies that its calibration measurements are traceable to the National Institute of Standards and Technology to the extent allowed by NIST's calibration facility.

WARRANTY

The warranty period for this instrument is stated on your invoice and packing list. Please refer to these to determine appropriate warranty dates. We will repair or replace the instrument during the warranty period provided it is returned to Valhalla Scientific, Inc. freight prepaid. No other warranty is expressed or implied. We are not liable for consequential damages. Permission and a return authorization number must be obtained directly from the factory for warranty repairs. No liability will be accepted if returned without such permission.

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SECTION I INSTALLATION

1-1. Initial Inspection

If the external shipping container shows evidence of damage, it should be immediately brought to the attention of the carrier and such damage noted on the bill of lading.

Unpack the instrument and retain the shipping container until the instrument has been inspected for possible damage in shipment. If shipment damage is observed, notify the carrier and obtain authorization for repairs before returning the instrument to the factory. If the external shipping container shows evidence of damage, but the instrument shows no external damage, it may be advisable to check the performance of the unit using the adjustment procedure of Section V as a guide to determine that the instrument has not incurred hidden damage.

1-2. Power Requirements

The instrument is shipped from the factory for operation from 115 or 230 volts AC 50/60 Hz. The internal operating input voltage range is selectable with a rear panel switch. When 115V is selected, the unit will operate at line voltages of 103 to 130 volts. When 230V is selected, the unit will operate at line voltages of 206 to 260 volts.

1-3. Installation

If the Model 2100 or Model 2101 is to be used in the bench top configuration, installation requires only that the line cord be connected to the rear panel connector and the other end inserted into the

appropriate wall receptacle. A rear panel mounted fuse provides protection for the internal circuits.

If the unit is to be installed in a rack, assemble the Wattmeter into the rack mount adapter using the instructions included with the option. Then it is only necessary to locate the unit in the rack, install the screws that attach it and make the power source and load connections. The unit should be operated only in areas where the ambient temperature does not exceed 50°C.

If the internal temperature of the rack mount in which the unit is installed will exceed this temperature limit, forced air cooling should be employed to maintain the ambient air at or below the 50°C limit.

SECTION II DESCRIPTION & SPECIFICATIONS

2-1. General Description

Valhalla Scientific Models 2100 and 2101 Digital Wattmeters are accurate, low-cost instruments to aid engineering, production test, and quality assurance departments in determination of product power consumption from DC and AC power sources. The instruments feature dual independent digital displays. One display provides a continuous indication of true power in watts. The other display is switch selectable between amperes (true RMS) and volts (true RMS).

The Model 2100 and Model 2101 provide a fast and convenient method of determining product efficiency, power factor, and true RMS current. Phase angle relationships may be calculated through utilization of the displayed digital data.

The Digital Wattmeters use a unique four-quadrant complex waveform analog multiplier to derive a DC signal equivalent to the integrated product of the instantaneous value of the line voltage and current. The resultant wattage value is converted for presentation on a 4½ digit display.

Power ranging provides maximum resolution from 10 milliwatts to 12,000 watts on the Model 2100 and from 1 milliwatt to 6,000 watts on the Model 2101. True RMS current from 100 microamperes (max resolution) through 19.99 amperes with a crest factor of 2.5:1 may be monitored by selecting the current display with the front panel switch. True RMS

voltage from 7.5 to 600 volts may be monitored on the Model 2100 by selecting the voltage display. On the 2101 the range is from 1.5 to 300 volts. Four binding posts on the rear panel provide convenient means of making the measured line and load connections.

The Digital Wattmeters are designed to operate from selectable 115/230V AC power. The loads may be operated from power sources up to 600 volts on the Model 2100 and up to 300 volts on the Model 2101. These load power sources may be independent of instrument power and may be DC or AC from 40 Hz to 20 kHz.

Peak voltage limitation is 1,500 volts for the Model 2100, and 750 volts for the Model 2101. There are three selectable current display ranges identified on the front panel as .2, 2, and 20 amperes. DC current may be displayed up to 0.5000, 5.000, and 20.00 amperes. AC sine wave current may be displayed up to 0.3500, 3.500, and 20.00 amperes.

Voltage display ranges are also selectable in three steps: 150.00, 300.0, and 600.0 on the Model 2100 and 30.00, 150.00, and 300.0 on the Model 2101.

2-2. Performance Specifications

Range & Resolution 2100

	.2000A	2.000A	20.00A
150.00V	30.00W	300.0W	30000W
300.0V	60.00W	600.0W	6000W
600.0V	120.00W	1200.0W	12000W

Range & Resolution 2101

	.2000A	2.000A	20.00A
30.00V	6.000W	60.00W	600.0W
150.00V	30.00W	300.0W	3000W
300.0V	60.00W	600.0W	6000W

AC/DC Voltage and AC/DC Current

Accuracy: (Voltage and Current)

DC & 40Hz to 5kHz: $\pm 0.1\%$ of reading ± 6 digits.

5kHz to 15 kHz: $\pm 0.5\%$ of reading ± 6 digits.

15kHz to 20kHz: $\pm 0.75\%$ of reading ± 6 digits.

(Useable to 50kHz with typically 1% error per 10kHz).

Crest Factor Response: 50:1 for minimum RMS input, linearly decreasing to 2.5:1 for full scale RMS input.

Minimum Input: 5% of range.

Maximum Input: 600V DC or RMS AC, 1500V peak.

Maximum Common Mode: 1500V peak, neutral to earth.

Peak Indicator: Illuminates at 2.5 x full scale.

Maximum Input: 35A peak, 20A DC or RMS; 100A DC or RMS for 16mS without damage.

Overrange: 150% of full scale for DC, up to maximum input.

Watts (True Power - $EI \cos \phi$)

Accuracy: $25^\circ\text{C} \pm 5^\circ\text{C}$, 1 year

DC & 40Hz to 5kHz: $\pm 0.25\%$ of reading ± 6 digits.

5kHz to 10kHz: $\pm 0.5\%$ of reading ± 6 digits.

10kHz to 20kHz: $\pm 1\%$ of reading $\pm 1\%$ of range (2A only).

10kHz to 50kHz: additional $\pm 1\%$ per 10kHz above 20kHz.

2-3. Physical Specifications

Displays: High intensity LED's.

Operating Temperature Range: 0°C to 50°C .

Temperature Coefficient: $\pm 0.025\%$ of range per $^\circ\text{C}$ from 0°C to 20°C and 30°C to 50°C .

Conversion Rate: Approximately 600mS (1 per second).

Power: 115/230 VAC $\pm 10\%$, 50-60Hz, 5 watts.

Size: 23.5cm L x 21.6cm W x 6.4cm H (9.25" x 8.5" x 2.0").

Weight: 2.3kg (5 lbs) net, 4.5kg (10 lbs) shipping.

Load Connection: 4 terminal heavy duty input jacks.

2-4. Standard Accessories

Models 2100 and 2101 are shipped from the factory with a detachable power cord and an instruction manual.

2-5. Optional Accessories

Option I-150: Clamp-on Current Transformer

Extends AC current measurement capability on the 2100 and 2101 to 150 amps RMS. The 1000:1 output ratio is 2% accurate from 50Hz to 400Hz. The unit accommodates up to $\frac{1}{2}$ " diameter conductors.

Option I-1000 Clamp-on Current Transformer

Extends AC current measurement capability to 1000 amps RMS. The 1000:1 ration CT is 2% accurate from 50Hz to 400Hz.

Option X21 Load Power Adaptor Cord

Approximately three feet in length for each half. Plugs directly into a standard 115V AC power outlet and mates with the 2100 or 2101 via heavy duty banana jacks. Female half provides for quick and easy load connect or disconnect.

Option CC4 Meter & Accessory Carrying Case

Option R4 Rack Mount Adaptor

Rack mount adaptor for use in rack-mount applications.

Option SP2 Two Year Spare Parts Kit

Option DMX: 2190/91 Compatibility

Both Model 2100 and 2101 series digital power analyzers can be used with the Valhalla 2190 or 2191 data conditioners to provide analog or BCD output.

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SECTION III OPERATION

3-1. Introduction

This section of the manual contains complete operating instructions for the Model 2100 and Model 2101 Digital Wattmeters.

3-2. Front Panel Controls and Indicators

There are nine push-button controls on the front panel. Their functions are detailed in the following paragraphs.

3-3. Power Push Button

Power is applied to the unit by pressing the POWER push button. Application of power is indicated by lighting of the power and voltage/current digital displays. The first depression locks the push button on its ON position and applies power to the unit. When it is depressed a second time, it returns to its outer position and disconnects power from the unit.

3-4. Amps/Volts Display Selectors

Display of amperes or volts on the right-hand display is selected by depressing either the "Amps" or "Volts" push button. The button remains in its depressed position until released by depressing the other button.

3-5. Current Range Selectors

There are three current range selections that are made with the "Current" push buttons. The push buttons are labeled .2, 2, and 20. The maximum current reading that may be displayed in each range is approximately .3500, 3.500, 20.00, respec-

tively. The selected push button remains locked in its depressed position until released by depressing another button in the current group.

3-6. Voltage Range Selectors

There are three voltage range selections that are made with the "Voltage" push buttons. The push buttons on the Model 2100 are labeled 150, 300, and 600. Those of the Model 2101 are labeled 30, 150, and 300. The maximum voltage that may be displayed in each range of the Model 2100 is 199.99, approximately 500.0 and 600.0, respectively. On the Model 2101 the voltage ranges are approximately 50.00, 199.99 and 300.0. The selected push button remains locked in its depressed position until released by depressing another button in the "Voltage" group.

3-7. Peak-Amp Overload Indicator

If the peak or steady-state current to the measured load is greater than 250% of the range selected with the "Current" push-button, the "Peak Amp O/L" indicator illuminates. Select the proper range or reduce the current to the load to extinguish the indicator. Do not rely on current or power indications if the indicator is illuminated.

3-8. Peak-Volt Overload Indicator

If the peak or steady-state voltage applied to the rear panel connectors is greater than 250% of the range selected with the "Voltage" push button, the "Peak Volt" O/L indicator will be illuminated. Selecting the proper range or reducing the voltage will

extinguish the LED. Do not rely on the voltage or power indications if the indicator is illuminated.

3-9. Volts/Amps Display

When "Volts" is selected, the right-hand digital display will show the voltage applied to the rear panel connectors. Resolution is 0.01 volts when the 30 volt range (Model 2101 only) or 150 volt range is selected and 0.1 volt resolution when the 300 volt range or 600 volt range (Model 2100 only) is selected.

When "Amps" is selected, the current supplied to the load will be displayed with the resolution of 0.0001 amperes when the .2 ampere range is selected, 0.001 amperes when the 2 ampere range is selected and 0.01 amperes when the 20 ampere range is selected. The display will blink if the voltage or current is greater than required for a display of 19999 (decimal omitted).

3-10. Wattmeter

The power dissipated in the load is indicated on the left-hand display. To obtain a valid display of power (wattage) requires that the peak voltage and current ranges be selected with the front panel push buttons. If voltage or current exceed those levels, the respective "Peak" indicator will be illuminated. These peak indicators occur independently of whether "Amps" or "Volts" has been selected for the right-hand display. In either case select a higher range or if the highest range has been selected and the peak indicator is still on, the voltage applied to and/or the current through the instrument must be reduced. This may require the use of external dividers and/or current shunts.

If external dividers or shunts are used, the power display will be a fraction of the

actual load power. Simple ratio calculations will then reveal the power actually delivered to the load.

To obtain power readings with maximum resolution, select increasingly lower ranges of current and voltage until the "Peak" indicators illuminate, then select the next highest range. Select current and/or voltage ranges to shift the decimal point in the power display.

Under certain conditions, where complex waveforms are applied to the instrument and load, it may be necessary to select a current and/or voltage range that is well above the true RMS value indicated on the display in order to extinguish the "Peak" indicator. This will reduce the resolution of the wattmeter reading, but is necessary for reading accuracy. The display will blink if the load power is greater than that required for a display of 19999 (decimal omitted).

3-11. Rear Panel Connections

The locations of the rear panel connections are shown in Figure 3-1. The function of the 115V/230V switch and power cord receptacle were covered in Section I. It is important to connect the load in accordance with the L (line) and N (neutral) indications on the rear panel for accurate measurement.

SECTION IV THEORY OF OPERATION

4-1. General

This section of the manual describes operation of the circuits of the Digital Wattmeters. A functional description is referenced to the block diagram of Figure 4-1 and is intended to assist the user in gaining a general understanding of instrument operation.

The circuit descriptions are of a more detailed nature and are intended to acquaint the user with circuit operation to the degree necessary for logical troubleshooting. The information contained in this section, together with that of Section V, will provide the background necessary

for maintenance of the instruments.

4-2. Functional Description

A block diagram of the Digital Wattmeters is shown in Figure 4-1. Power for the load under test is connected to one set of rear panel terminals and passes through the instrument to a second set of terminals where the external load under test is connected. A 0.01 ohm current shunt is installed between one input terminal and one output terminal. The inputs to the voltage amplifier are connected to both power line terminals. The inputs to the three-stage current amplifier are connected across the current shunt.

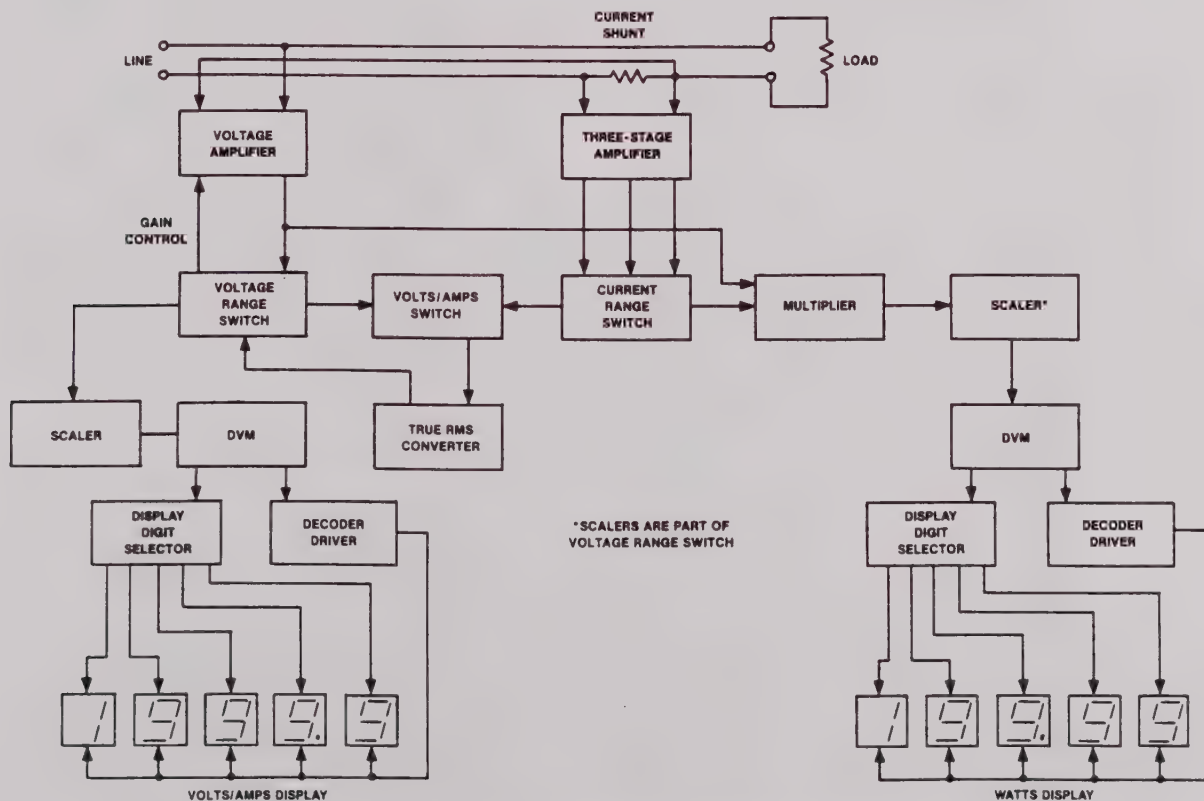


Figure 4-1. Block Diagram: Digital Wattmeter

The voltage amplifier gain is controlled by the voltage range switch so that it has a full-scale 5-volt output at the selected range. The gains of the three stages of the current amplifier are 25, 10 and 10, respectively. The outputs of each current amplifier stage are individually selected by the current range switch for the .2, 2 and 20 ampere ranges.

The signal applied to the true RMS converter is determined by the position of the amps/volts selector switch. The 5-volt full-scale output of the voltage amplifier is the same for the three ranges, the output of the RMS converter will be passed through the scaler when the voltage amplifier output is selected. The scale factor is controlled by the voltage range switch, which selects the correct voltage to be applied to the RMS converter. If a current amplifier output is selected, scaling is not required. However, the current range switch will place the decimal point of the display in the proper position for the selected range.

The DVM is a true dual slope, integrating digital voltmeter. The full-scale voltage applied to its input is 0.2 volts in the current ranges and 1.5, 0.3 and 0.6 volts in the three voltage ranges of the Model 2100 and 0.3, 1.5 and 0.3 volts for the ranges of the Model 2101. The voltage measured by the DVM is latched to its internal registers at the end of the measurement cycle. During the time of the next input measurement, each digit of the previously measured voltage is sequentially applied to the inputs of the decoder/driver. While the decoded data is present at the output of the decoder/driver, the display digit selector energizes the appropriate display digit. Thus, the display is multiplexed from a single BCD output of the DVM and at such a rate that it appears to be continuously illuminated.

The output of the voltage amplifier and the output of the current amplifier stage selected with the current range switch are applied to individual inputs of the power converter which is a multiplier circuit. The output of the power converter is passed through a scaler which is controlled by the voltage range switch. Again, scaling is necessary since the full-scale output of the voltage amplifier is the same on all ranges. The DVM which follows the scaler is identical to that used for the amps/volts display. However, its decimal point has only two positions and these are controlled by the voltage range switch.

4-3. Circuit Descriptions

To supplement the overview provided by the preceding functional description, this section describes the operation of each circuit. The reference designators used in this section are those of the schematic diagram of the Model 2100, Figure 5-5. The schematic of the Model 2101, shown in Figure 5-6, is slightly different, but the principles are the same. The individual circuits of a multiple-circuit device are identified by the device designator followed by a suffix number corresponding to the output pin number. For example, the amplifier of IC7 that has its output connected to pin 1 is identified as IC7-1.

4-4. Power Supply

The power supply schematic is located in the lower left area of Figure 5-5. S1 is the front panel push button switch that connects one side of the power line to one end of the primary windings of transformer T1. The other end of the primary windings is permanently connected to the other side of the line. T1 has two primary windings that are connected in parallel by S10 for operation on 115 volts and in series for operation on 230 volts.

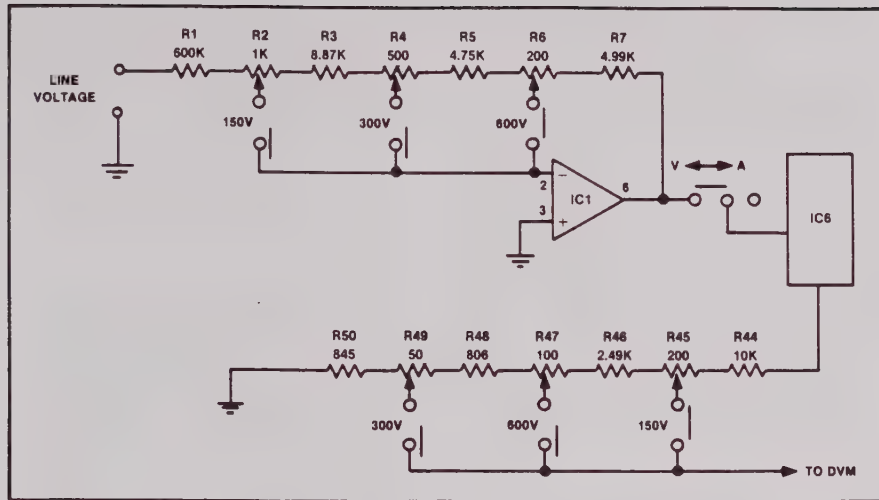


Figure 4-2 Simplified Circuit Diagram Voltage Amplifier, Model 2100

The voltage across one secondary winding of T1 is rectified by D1 and D3 and filtered by C18 to provide +5 volts to the display driver transistors TR1 through TR5 and TR8 through TR12, and to IC21. The other secondary is rectified by D6 and D7 to provide a positive DC input to voltage regulator IC11 which develops +15 volts at its output. The same secondary is also rectified by D4 and D5 to provide the negative DC input to voltage regulator IC12 which develops -15 volts at its output. These voltages power the devices that are not connected to the +5 volt supply.

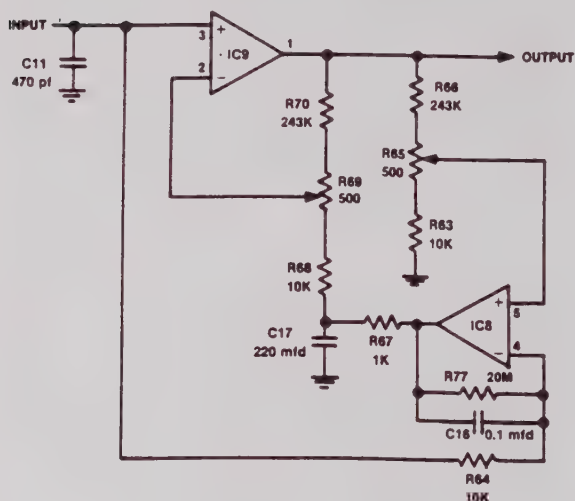
The neutral input terminal is connected to the internal common bus (ground). T1 provides isolation between the common bus and the power line. The plastic case and other insulators isolate the operation from the input terminals. However, when the unit is opened for service, personnel should verify that the neutral terminal is at the same potential as the power line ground or serious injury could occur.

4-5. Voltage Amplifier and Scaling

The neutral line of the input (measured) voltage source is connected to the common internal bus (ground). The other line is connected to the input of the voltmeter amplifier circuit through a 600K ohm resistor, R1, on the rear panel assembly. Refer to Figure 4-2. This is a simplified diagram of the operational amplifier circuit IC1 and RMS voltage converter IC3. The three switches connected to the input of IC1 are sections of the voltage range selector. The number adjacent to each switch indicates the selected range for which it is closed.

The gain of IC1 is determined by the closed section of the switch which selects the resistance value for the feedback loop of IC1. R2, R4 and R6 provide fine adjustments of gain in each range. The output of IC1 for full-scale input (150, 300 or 600 volts) is 5 volts. R8 provides the offset adjustment for IC1.

**Figure 4-3. Simplified Circuit Diagram
Current Input Amplifier**



The output of IC1 passes through switch S5B, which selects the output of the voltage or current amplifiers as an input to IC6. When the "Volts" mode is selected, the output of IC6 is a DC voltage directly proportional to the RMS value of the input voltage and will be 5 volts full-scale. It appears across the voltage divider comprised of R44 through R50. The switches connected to the arms of the potentiometers in this voltage divider are other sections of the range switch that close simultaneously with those in the feedback circuit of IC1. The output of IC6 is scaled down through the divider to 0.6 volts for the 600 volt range, 0.3 volts for the 300 volt range and 1.5 volts for the 150 volt range, with the potentiometers providing the line calibration adjustments.

4-6. Current Amplifiers and Scaling

The source of the signal for the current meter is a 0.01 ohm shunt resistor, R61, through which the load current flows. The resistance of R61 is very low so there is minimal effect on the voltage applied to the load. The signal developed across R61 must be amplified, especially in the lowest

current range. The current signal amplifiers are shown in Figure 5-5. A simplified diagram of the input current amplifier is shown in Figure 4-3. The minimal full-scale voltage developed across R61 is only 2 millivolts. Therefore, the input amplifier must remain stable at DC from 40 Hz through 5 Hz.

Operational amplifier IC9-1 and chopper-stabilized amplifier IC8 operate in concert to achieve the required stability. Any offset appearing at the output of IC9-1 is reduced by a factor of 25 at the arm of R65 where it is applied to the non-inverting input of IC8. A differential exists between the two inputs of IC8. An offset is produced at the output of IC8 that places a charge on C17 with a polarity that drives the output of IC9-1 toward zero. The gain of IC8 is 200 and its output is integrated by R67 and C17 which eliminates any tendency toward oscillation. The system finds a point of equilibrium where the offset at IC9-1 has been reduced to a negligible level.

IC9-1 has a gain of 25 and the amplifiers that follow, IC9-7 and IC10-6, have a constant gain of 10 when properly adjusted with R74 and R85. The output of IC9-1, IC9-7 and IC10-6 are each connected to one contact of the "Current" switch. The other contact is connected to its counterparts so that the selected output is applied to the true RMS converter, IC6, when "Amps" is selected with the "Volts/True RMS/Amps".

A 200 millivolt input to IC9-1 produces 5 volts at the output of IC9-7 and 2 millivolts produces 5 volts at the output of IC10-6. The full-scale voltage applied to the true RMS converter in any range is 5 volts.

The output of the true RMS converter appears across the divider comprised of

R51, R52 and R53. The potential at the arm of R52 is 200 millivolts and is applied to the amps/volts DVM, IC20, through a section of the "Volts/True RMS/Amps" switch when "Amps" is selected.

4-7. Peak Detector/Indicators

When the voltage applied to the rear panel terminals exceeds the selected voltage range, the peak voltage indicator illuminates. This signals that the displayed voltage and power value may not be accurate. An identical circuit provides a visual signal when the current to the load exceeds the selected current range. The peak detectors provide their visual signals irrespective of whether "Amps" or "Volts" has been selected for display.

The voltage peak detector is comprised of comparators IC2-1, IC2-2 and IC2-13. Their circuit is shown in the upper area of Figure 5-5. The reference voltage at the inverting input of IC2-1 is at -12 volts, which is derived from the divider comprised of R11 and R12. The non-inverting input is connected to the output of the voltage amplifier, IC-16. The non-inverting input of IC2-2 is at +12 volts which is derived from the divider comprised of R9 and R10. Its inverting input is also connected to the output of IC1-6. When zero volts is applied to the input, the outputs of both comparators are high (+15 volts). Since the inverting input of IC2-13 is at ground potential, its output will be high, back-biasing voltage peak indicator DS2 and holding it out of conduction.

When the input voltage (either peak or steady-state) exceeds +12 volts, the output of IC2-1 will transition to -15 volts, causing the output of IC2-13 to transition to -15 volts, turning on DS2. When the input voltage exceeds -12 volts, the output of IC2-2 and IC2-13 will transition to -15 volts

to turn on DS2. An integrating capacitor, C1 holds the output of IC2-13 at a low state between peaks so that DS2 is continuously illuminated until the input to IC2-13 is increased above its transition level.

An identical circuit for the current peak detector/indicator is comprised of IC7-1, IC7-2, IC7-13 and associated components. The input to this detector is from the "Current" range switch which connects it to the output of the selected current signal amplifier.

4-8. Digital Voltmeters

There are two near-identical digital voltmeter (DVM) circuits. One, shown in the lower right area of Figure 5-5, drives the "Amps/Volts" display. The other, shown in the upper right area, drives the "Watts" display. Most of the amps/volts DVM circuitry is contained in two special devices, IC19 and IC20, which comprise a dual-slope integrating voltmeter.

The analog circuits are contained in IC19 and the digital circuits in IC20. The circuit of the watts DVM is comprised of IC17 and IC16 and associated components.

A dual-slope integrating voltmeter has three cycles. Timing of these cycles is controlled by a crystal oscillator, IC21, which operates at 100 kHz. The first cycle is auto-zero which nulls out any offsets. The next integrates the input for a precise time (10,000 counts of the oscillator). In the process, it charges a capacitor to a level proportional to the input voltage. In the third cycle, a fixed level reference voltage of reverse polarity is applied to the integrator. The time required for the integrator to discharge its capacitor back to zero in this cycle is determined by counting the oscillator pulses. This count is an

accurate measurement of the input voltage. The reference cycle count is displayed as the measured voltage.

4-9. Auto Zero

IC19 contains an integrator and a comparator. During the auto-zero cycle, an internal switch to IC20, which is connected between pins 16 and 17, connects the output of the comparator at pin 2 of IC19 to the input of the integrator at pin 12 of IC19. This charges auto-zero capacitor C33. The auto-zero cycle time is sufficient to completely charge the capacitor and zero the output of the integrator. The capacitor will hold its charge during the next two periods. The input reference capacitor, C34, is also charged to a reference level during this period.

4-10. Input Integration

The output of true RMS converter IC6 is connected to pin 10 of IC20 through a scaling voltage divider that is part of the voltage range switch. During the input integration period, an internal switch for IC20 connects pin 10 to pin 9 and to the input of the integrator of IC19. C32 is the integrator capacitor. At the end of the input integration period, C32 is charged to a level proportional to the input voltage. At the same time, the polarity of the input is latched in IC20.

4-11. Reference Integration

At the beginning of the second integration period, the switches in IC20 will select the reference voltage at pin 7. This reference is obtained from pin 6 of IC16, in the watts DVM circuit, through R98, R99 and R107. R107 provides a fine adjustment of the reference input. The reference is applied to the integrator to return its output to zero. During this integration period, the

crystal oscillator drives a multi-stage counter. When the integrator output crosses zero, counting is terminated. The number of counts required to integrate the reference to zero, which is stored in the counter, is precisely proportional to the input voltage.

4-12. Amps/Volts Display

The reference integration counts, which are accumulated in an internal counter of IC20, are latched into a multiplexer, also internal to IC20, at the end of the count period. During the next series of auto-zero and integration periods, each digit of the counts latched into the multiplexer are sequentially placed on the BCD outputs of IC20 and on the inputs of decoder/driver IC18. While the most significant digit data is applied to IC18, transistor TR8 is turned on by IC20 to provide the anode voltage for DS8.

When the next digit data is applied to IC18, TR8 is turned off and TR9 is turned on to provide the anode voltage for DS9. The sequence is continued for TR10/DS10, TR11/DS11 and TR12/DS12 and then repeated. The repetition rate is fairly high so that all digits appear to be continuously illuminated.

4-13. Decimal Point Positioning

The decimal points in the "Amps/Volts" display are positioned by the "Voltage" switch when the "Volts" function is selected. Pin 6 of the display device is the decimal input. In the 150-volt range, pin 6 of DS10 is grounded through contacts of the "Current" switch so that the resolution is 0.01 volts. In the 300- and 600-volt ranges, pin 6 of DS11 is grounded and the resolution is 0.1 volts. When the "Amps" function and the 0.2 range are selected, pin 6 of DS9 is grounded and the reading resolution is 0.0001 amperes. Pin 6 of DS10 is grounded in the 2 ampere range

for a display resolution of 0.001 amperes. For the 20 ampere range, display resolution is 0.1 amperes, since pin 6 of DS11 is grounded. Note that the path to ground is through the switch and 100-ohm resistor R54.

The decimal points of the watts display are controlled only by the "Current" range switch. Pin 6 of DS6 is grounded in the .2 ampere range for a display resolution of 0.01 watts. In the 2 ampere range, pin 6 of DS7 is grounded for resolution of 0.1 watts. No decimal point is displayed in the 20 ampere range. The watts display decimal points are grounded through the current switch and 100-ohm resistor R87.

4-14. Analog Multiplier

Analog multiplier IC3 receives the output of voltage amplifier IC1-6 and the output of either IC9-1, IC9-7 or IC10-6, depending on the selected current range.

The output current from IC3 is proportional to the product of the signals at its two inputs. This output current is converted to a voltage by IC4-6.

The analog multiplier (IC3) is direct coupled and is, therefore, subject to DC shift at its output due to temperature changes. To correct for this shift, an auto zero circuit is used. It consists of IC5, the switches of IC13 and IC14 and associated components. The switch drivers are shown in the upper right area of Figure 5-5. Each of the eight switch drivers is identified by an alpha character. The switch sections are shown in a manner that simplifies the diagram and facilitates the understanding of circuit operation. Each switch section in the main part of the diagram is identified with the same alpha character as its driver. The circuit switches the two inputs to the multiplier to zero and meas-

ures the offset voltage output at IC4-6. IC5 amplifies the offset voltage and charges C4 to a voltage that will drive IC4-6 to zero. The inputs to the multiplier are switched back to the signal source. This sequence occurs during every auto-zero cycle.

4-15. Model 2101 Circuit

The Model 2100 and Model 2101 circuits are nearly identical and are assembled on identical circuit boards. The principal differences between them are:

- Some resistors installed in the Model 2100 are not installed in the 2101.
- The values of a number resistors are different.
- There are some minor switch wiring changes.
- NAND gates IC22 and IC23 are installed only in the Model 2101.

The purpose of IC22 and IC23, which are shown in Figure 5-6, is to control the display decimal points. The decimal point of DS5 is used in the Model 2101 to increase the resolution of the display in the lowest current and power ranges. This requires that the decimal point illumination of the display be controlled by the "Voltage" and "Amps" range switches. This is accomplished through the NAND gates of IC22 and IC23.

SECTION V MAINTENANCE

5-1. Recommended Test Equipment

- (1) Two DC Voltage Standards (Valhalla Scientific Model 2701C or equivalent).
- (2) AC Voltage Standard (Valhalla Scientific Model 2703 and 2705 or equivalent.)
- (3) AC-DC Current Calibrator (Valhalla 2500EP or equivalent).

5-3. Calibration Procedures

The following procedures should be performed at routine intervals to insure that the Digital Wattmeters remain within specified limits. In addition, calibration should be performed whenever repairs have been completed involving accuracy determining components.

- (1) Remove the top cover from the unit to gain access to the internal adjustments.
- (2) Apply power to the 2100 and test equipment, and allow approximately thirty minutes for stabilization.

5-4. Model 2100 Procedure

The following procedure applies only to the Model 2100. Refer to paragraph 5-21 for the Model 2101 procedure.

- (1) Connect the positive terminal of the DVM to pin 7 of IC20 and the negative terminal to analog ground. Adjust R100 if necessary for a DVM reading of +1.000 volts.

- (2) Connect the positive terminal of the DVM to pin 7 of IC17 and the negative terminal to analog ground. Adjust R107 if necessary for a DVM reading of +1.000 volts.

CAUTION

The neutral input terminal is connected to the internal common bus (ground). Transformer T1 provides isolation between the common bus and the power line. The plastic case and other insulators isolate the operator from the input terminals when the cover is in place. However, when the unit is opened for service, verify that the neutral terminal is at the same potential as the power line ground. If connected to a high potential and internal circuitry is contacted, **SERIOUS INJURY MAY RESULT.**

- (3) Connect the 2100 to Reference Standards per Table 5-1. Perform the adjustments listed in Table 5-1. Note the location of TP1 in Figure 5-1.

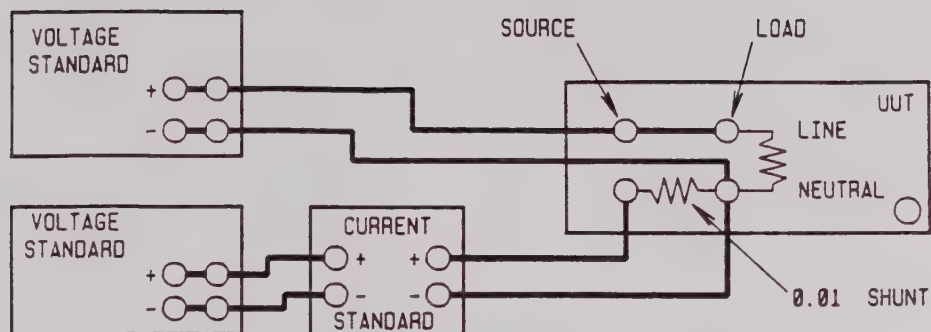


Figure 5-1. Calibration Equipment Connections

Table 5-1. Model 2100 Voltage Adjustments

	Range	DC Voltage Calibrator Output	Adjust	TP1 DVM Reading	Adjust	2100 Display Reading
1	150	10.00 VDC	-	-	R8*	10.00
2	150	150.00 VDC	R2	-5.000 VDC	R45	150.00
3	300	300.00 VDC	R4	-5.000 VDC	R49	300.00
4	600	600.00 VDC	R6	-5.000 VDC	R47	600.00
5	150	150.00 VDC	Reduce for Current Range Calibrations			

* Alternate input polarity and adjust R8 for the same reading at both polarities.

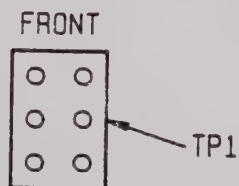


Figure 5-2. TP1 Location/Switch S5 (Amps)

Table 5-2. Model 2100 Current Adjustments

	Range	DC Current Calibration Output	Adjust	2100 Current Display
1	20A	10.0000 ADC	R65	-2.500 at TP1
2	20A	10.0000 ADC	R52	Adjust R52 for 10.00 reading on display
3	2A	1.0000 ADC	R71	Alternate + and - polarity and balance for same reading on display
4	2A	1.0000 ADC	R74	1.000
5	0.2A	0.10000 ADC	R83	Alternate + and - polarity and balance for same reading on display
6	0.2A	0.10000 ADC	R85	.1000

- (4) Select the "Volts" display. Perform the adjustments in Table 5-2.
- (5) Select the "Amps" display. Select the 2 amp 600 volt range. Apply 1 amp and reduce the input voltage to zero. Alternate the input current polarity and adjust R29 for the same reading at both polarities. Adjust R43 for 000.0 on the watts display (300 volt range on the 2101).
- (6) Reduce the input current to zero (600 volt range). Apply 150 volts, alternate the input voltage polarity, and adjust R28 for the same reading at both polarities. The balance reading should be ± 3 digits from 000.0. If reading is not within the specified limits, adjust R43 for a reading of 000.0, then repeat step 5.
- (7) Select the 1 amp range and the 600 volt range. Apply 1 amp and 600 volts to the 2100. Adjust R36 for a reading of 600.0 on the watts display. Reverse the current and volts polarity and adjust R36 for the same reading at both polarities.
- (8) Reduce the input voltage to 150 VDC (600 volt range) and verify linearity.
- (9) Select the 300 volt range and increase the input voltage to 300.0 volts. Adjust R34 for 300.0 on the watts display. Reverse the input voltage and current polarity, and adjust R34 for a balance between both polarities.
- (10) Reduce the input voltage to 150 VDC and select the 150 volt range on the 2100. Adjust R32 for 150.0 on the watts display. Reverse the input voltage and current polarity, and adjust R32 for a balance between both polarities.
- (11) Replace the DC voltage standards illustrated in Figure 5-1 with the AC Wattmeter Calibration System (Valhalla 2703 Master, 2705 Slave). Select the 150 watt and the 20 amp ranges.
- (12) Apply 150 volts AC and 10 amps AC (100 Hz) with a zero phase difference. Adjust R69 for 10.00 on the current display.
- (13) Verify that all volts, current, and watts ranges are within specifications. If the 2703/2705 Wattmeter Calibration System is used, verify the power factor response at 90, 120, 180 and 240 DEGs.

5-5. Model 2101 Calibration Procedure

(2) Omit step 7.

The Model 2101 is calibrated the same as the Model 2100 with the following exceptions:

(3) Verify 30 watts full scale (1 amp x 30.00 volts).

(1) Use the adjustments on Table 5-1.

Table 5-3. Model 2101 Voltage Adjustments

	Range	DC Voltage Calibrator Output	Adjust	TP1 DVM Reading	2100 Adjust	Display Reading
1	150	10.00 VDC	-	-	R8*	10.00
2	30	30.00 VDC	R2	-5.000 VDC	-	-
3	150	150.00 VDC	R4	-5.000 VDC	R45*	150.00
4	300	300.00 VDC	R6	-5.000 VDC	R49+*	300.00
5	150	150.00 VDC	Reduce for Current Range Calibrations			

* Alternate input polarity and adjust for the same reading at both polarities.

+ The 30 volt and 300 volt ranges are adjusted using R49.

5-6. Using the 2100/2101 Digital Power Analyzer with Current and Potential Transformers

The current and voltage ranges of the 2100 and 2101 may be extended using current and potential transformers. Current transformers (CT's) are used to extend the current range of the 2100 or 2101. CT's

are available in many division ratios, e.g., 1000:1, 100:1, 10:1, and 1:1. When using a CT with the 2100, the operator must multiply the current and power readings by the ratio of the CT used. The bandwidth and ratio accuracy of the CT will affect the overall current and power measurement accuracy. The CT connections are shown in Figure 5-3.

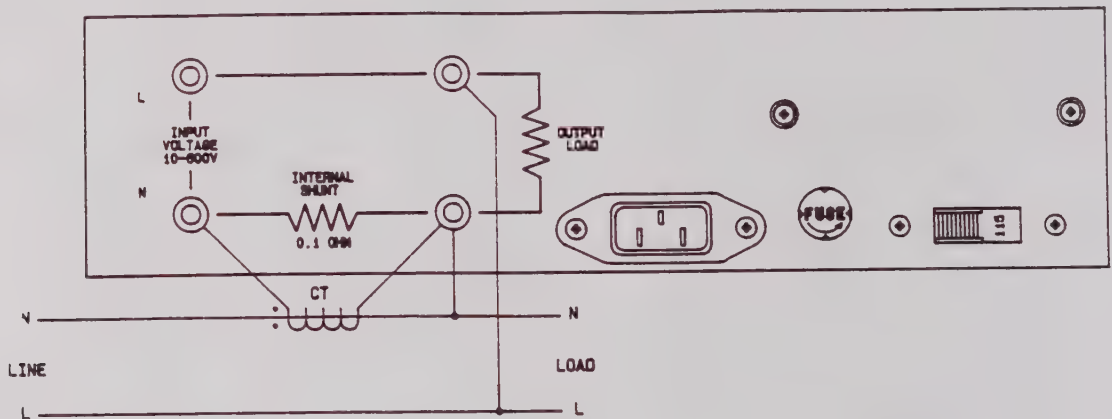


Figure 5-3. Current Transformer Connections

Potential Transformers (PT's) are used to extend the voltage range of the 2100. PT's are available in many division ratios, e.g., 10:1, 100:1, 1000:1. When using a PT with the 2100, the operator must multiply the

voltage and power readings by the ratio of the PT used. The bandwidth and ratio accuracy of the PT will affect the overall voltage and power measurement accuracy. The PT connections are shown in Figure 5-4.

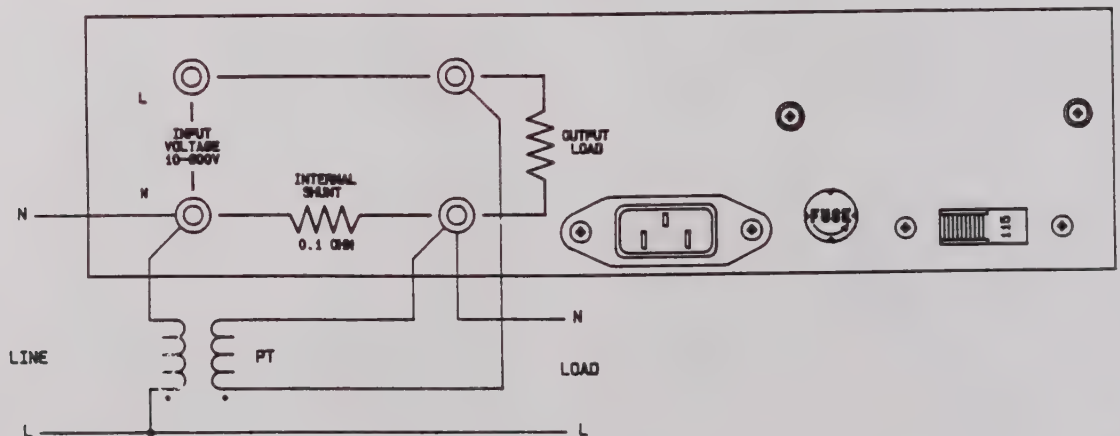


Figure 5-4. Potential Transformer Connections

When measuring high voltages with the 2100, do not exceed the 1500 volt common mode specification. Use both a CT and

PT to isolate the 2100 from the high voltage source. The PT-CT connections are shown in Figure 5-5.

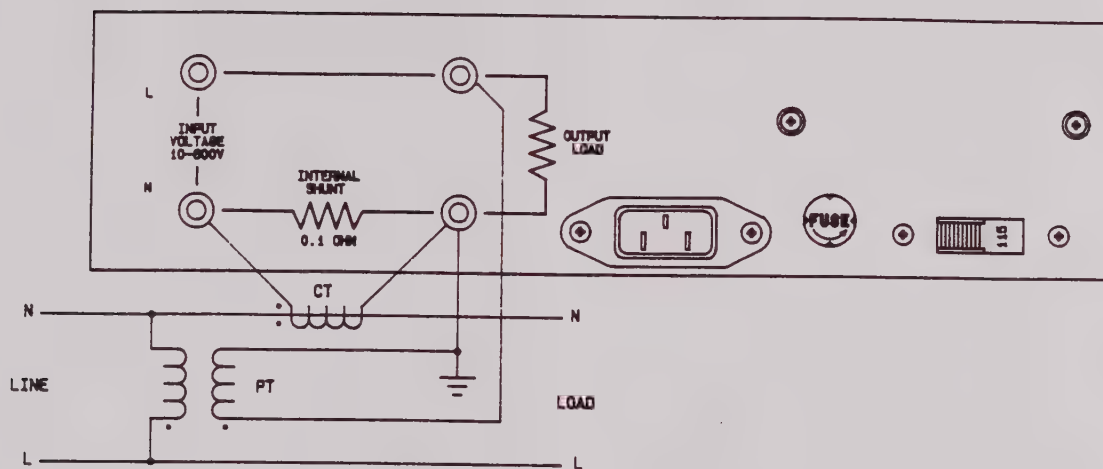


Figure 5-5. Current Transformer-Potential Transformer Connections

SECTION VI PARTS LISTS

The following parts lists are included in this manual:

Parts List	Description	Pages
2100-400	Final Assy.	1
2100-403	Final Assy.	1
2100-404	Final Assy.	1
2100-600	Main Bd. Assy.	5
2100-601	Display Bd. Assy.	1

REF.DES.	STOCK #	QUANTITY	DESCRIPTION	MANUFACTURING/PURCHASING DATA	ALTE
		A T N			
1	2100-600	1	Main Board Assy.	Assembly 2100-600	
2	01-20103	1	Shunt Assy.	ASSY 2100-401	
5	04-10397	1	rear panel	DWG 2100-213	
6	04-10130	1	Chassis	PAKTEK CH250-BEIGE ETC.	
7	04-10309	1	Input Terminal Shield	DWG 2100-210	
8	04-10285	1	shorting strap	DWG 2100-207	
9	05-10063	1	Connector, AC, receptacle	Switchcraft EAC-301	
10	05-10018	1	Fuseholder, panel mount	Littlefuse 345061	
11	05-04010	1	0.25A,Slo Blo Fuse	Littlefuse,313-.250	
12	05-03017	1	Slide Switch,115/230V,2Pole	Switchcraft,4625LFR	
13	05-10020	2	Binding post, black, 30 amp	Superior BP308	
14	04-20038	1	power transformer	DWG 2100-010	
15	05-10198	4	Spacer, 1/4 dia, 1/8 lg, #4, nylon	Smith 8880	
16	05-10450	1	Solder lug, #10	Smith 1410-10	
17	90-04608	8	#4 x 1/2" Self-Tap Phil Pan S.S.		
18	90-06006	6	#6-32 x 3/8" Phil Pan S.S.		
19	98-06001	5	#6 Split Lock Washer,STD,S.S.		
20	97-06001	6	#6-32 Hex Nut,SMALL PATTERN ,S.S.		
21	05-10067	1	Cable, power cord	Electrocord 39806	
23	05-10086	1	Solder lug, #6, internal star	Smith 1412-6	
25	05-10085	1	Grommet, 11/32 od, 1/8 id, 1/4 panel dia	Smith 91114	
26	05-10252	2	binding post cut off	DWG 2100-211 using 05-10020	
27	05-10490	2	Washer, .562 od, .203 id, .04 thick, S.S.	Seastrom 5710-292-40	
30	05-10218	1	Hole plug	Calmark 810-25 BLACK	
33	05-10019	8	Cable tie, 4"x 1/8"	Panduit WRN-4	
34	90-06012	4	#6-32 x 3/4" Phil Pan S.S.		
36	99-10000	1	#10 18-22awg Ring Lug (Red)		
37	80-01522	4	22awg Wire, Green PVC	M16878/1-BFE-5	
40	80-02022	12	22Awg Wire, Black TFE	M16878/4-BFE-0	
41	80-02922	12	22awg Wire,White TFE	M16878/4-BFE-9	
42	80-02118	5	18awg wire, brown TFE	M16878/4-BHE/1	
R1	01-10089	1	600K 1% 80ppm/C 1W Metal Film	Caddock MG714-600K-1%	

REF.DES.	STOCK #	QUANTITY			DESCRIPTION	MANUFACTURING/PURCHASING DATA	ALTERNAT
		A	T	N			
8	04-10490		1		Front Panel (screened)	DWG 2100-100 using 04-10307	
R2	01-50013	1			1K Top adjust	Beckman 68WR1K	
R3	01-10141	1			8.87K 1% 50ppm/C 1/4W Metal Film	RN60C8871F	
R4	01-50029	1			500 Top adjust	Beckman 68WR500ohm	
R5	01-10142	1			4.75K 1% 50ppm/C 1/4W Metal Film	RN60C4751F	
R6	01-50037	1			200 Top adjust	Beckman 68WR200ohm	
R7	01-10016	1			8.45K 1% 50ppm/C 1/4W Metal Film	RN60C8451F	
R36	01-50014	1			100 Top adjust	Beckman 68WR100ohm	
R47	01-50014	1			100 Top adjust	Beckman 68WR100ohm	

REF.DES.	STOCK #	QUANTITY	DESCRIPTION	MANUFACTURING/PURCHASING DATA	ALTER
		A T M			
8	04-10491	1	2101 front panel (screened)	DWG 2101-100 using 04-10307	
IC22	03-30161	1	Quad 2 Input NAND Open Collector	7438N	
IC23	03-30161	1	Quad 2 Input NAND Open Collector	7438N	
R2	01-50040	1	5K Top adjust	Beckman 68WR5K	
R3	01-10154	1	73.2K 1% 50ppm/C 1/4W Metal Film	RN60C7322F	
R4	01-50013	1	1K Top adjust	Beckman 68WR1K	
R5	01-10155	1	10.2k Ohm, 1%, 1/4W		01-1009
R6	01-50029	1	500 Top adjust	Beckman 68WR500ohm	
R7	01-10156	1	11.3K 1% 50ppm/C 1/4W Metal Film	RN60C1132F	
R109	01-01061	1	10K 5% 1/4W Carbon Film	RC07GF103J	
R110	01-01025	1	200 5% 1/4W Carbon Film	RC07GF201J	
R111	01-01025	1	200 5% 1/4W Carbon Film	RC07GF201J	
R112	01-01025	1	200 5% 1/4W Carbon Film	RC07GF201J	
R113	01-01025	1	200 5% 1/4W Carbon Film	RC07GF201J	
R114	01-01021	1	100 5% 1/4W Carbon Film	RC07GF101J	
R115	01-01021	1	100 5% 1/4W Carbon Film	RC07GF101J	
R116	01-01021	1	100 5% 1/4W Carbon Film	RC07GF101J	

REF.DES.	STOCK #	QUANTITY			DESCRIPTION	MANUFACTURING/PURCHASING DATA	ALTERNAT
		A	T	N			
192	05-10007	1			Terminal, turret, swage	Usec0 1300B-1	
193	04-10334	1			PCB Shield	DWG 2100-212	
194	05-10276	3			Spacer, 1/4 dia, 1/2 lg, #6, nylon	Smith 4016	
195	05-10086	1			Solder lug, #6, internal star	Smith 1412-6	
196	90-06012	3			#6-32 x 3/4" Phil Pan S.S.		
197	97-06001	3			#6-32 Hex Nut, SMALL PATTERN, S.S.		
198	98-06001	3			#6 Split Lock Washer, STD, S.S.		
199	80-02022	3			22Awg Wire, Black TFE	M16878/4-BFE-0	
200	05-10657	4			Connector Spcr, .0471D, .1250D, .030-1.250LG	BIVAR 939-065	
A1	04-30070	1			Main Board	DWG 2100-700	
A2	2100-601	1			Display Board Assy.	Assembly 2100-601	
C1	02-30001	1			10u 25V Tantalum Bead	AVX TAP106K025SP	
C2	02-10004	1			0.02u 500V Ceramic disc		
C3	02-30001	1			10u 25V Tantalum Bead	AVX TAP106K025SP	
C4	02-10002	1			500p 100V Ceramic disc		
C5	02-30000	1			4.7u 16V Tantalum Bead		
C6	02-30001	1			10u 25V Tantalum Bead	AVX TAP106K025SP	
C7	02-60002	1			0.1u 250V Mylar	Illinois 104MSR250K	
C8	02-60002	1			0.1u 250V Mylar	Illinois 104MSR250K	
C9	02-30001	1			10u 25V Tantalum Bead	AVX TAP106K025SP	
C10	02-10004	1			0.02u 500V Ceramic disc		
C11	02-10002	1			500p 100V Ceramic disc		
C12	02-10014	1			0.1u 50V Ceramic disc	8121-050-651-104M	
C13	02-10014	1			0.1u 50V Ceramic disc	8121-050-651-104M	
C14	02-10006	1			0.01u 50V Ceramic disc	8121-050-651-103M	
C15	02-10006	1			0.01u 50V Ceramic disc	8121-050-651-103M	
C16	02-10009	1			0.001u 50V Ceramic disc		
C17	02-40030	1			220u 16V Alum. Radial		
C18	02-40000	1			4700u 16V Aluminum	Illinois 478TTA016	
C19	02-40013	1			470u 50V Aluminum	Illinois 477TTA050	
C20	02-40013	1			470u 50V Aluminum	Illinois 477TTA050	
C21	02-30001	1			10u 25V Tantalum Bead	AVX TAP106K025SP	
C22	02-30001	1			10u 25V Tantalum Bead	AVX TAP106K025SP	
C23	02-10013	1			1u 50V Ceramic disc	8131-050-651-105M	
C24	02-10006	1			0.01u 50V Ceramic disc	8121-050-651-103M	
C25	02-90003	1			5u 5% 50V Polycarbonate		
C26	02-50000	1			0.22u 10% 50V Polystyrene	F-Dyne FSA 0.22uF 10% or Equiv.	
C27	02-30000	1			4.7u 16V Tantalum Bead		
C28	02-30001	1			10u 25V Tantalum Bead	AVX TAP106K025SP	
C29	02-30001	1			10u 25V Tantalum Bead	AVX TAP106K025SP	
C30	02-10007	1			330p 1000V Ceramic disc		
C31	02-60002	1			0.1u 250V Mylar	Illinois 104MSR250K	
C32	02-50000	1			0.22u 10% 50V Polystyrene	F-Dyne FSA 0.22uF 10% or Equiv.	
C33	02-30000	1			4.7u 16V Tantalum Bead		
C34	02-30001	1			10u 25V Tantalum Bead	AVX TAP106K025SP	
C35	02-30001	1			10u 25V Tantalum Bead	AVX TAP106K025SP	
C36	02-10006	1			0.01u 50V Ceramic disc	8121-050-651-103M	
C37	02-20012	1			10p 500V Mica	CM05FD100J03	
C38	02-20013	1			100p 500V Mica	CM05FD101J03	
D1	03-20002	1			Diode, rectifier, 1A, 50V	1N4001-1N4007	
D2	03-20002	1			Diode, rectifier, 1A, 50V	1N4001-1N4007	

REF.DES.	STOCK #	QUANTITY	DESCRIPTION	MANUFACTURING/PURCHASING DATA	ALTERN
		A T N			
D3	03-20002	1	Diode, rectifier, 1A, 50V	1N4001-1N4007	
D4	03-20002	1	Diode, rectifier, 1A, 50V	1N4001-1N4007	
D5	03-20002	1	Diode, rectifier, 1A, 50V	1N4001-1N4007	
D6	03-20002	1	Diode, rectifier, 1A, 50V	1N4001-1N4007	
D7	03-20002	1	Diode, rectifier, 1A, 50V	1N4001-1N4007	
D8	03-20000	1	Diode, general purpose	1N4148 or 1N914	
D9	03-20000	1	Diode, general purpose	1N4148 or 1N914	
D10	03-20000	1	Diode, general purpose	1N4148 or 1N914	
D11	03-20000	1	Diode, general purpose	1N4148 or 1N914	
D12	03-20000	1	Diode, general purpose	1N4148 or 1N914	
D13	03-20000	1	Diode, general purpose	1N4148 or 1N914	
IC1	03-30090	1	General Purpose JFET Op-Amp	LF356N or H (ALT 03-30074)	
IC2	03-30133	1	Quad general purpose comparator	LM339N	
IC3	03-30091	1	Analog Multiplier	Raytheon RC4200AN8	
IC4	03-30090	1	General Purpose JFET Op-Amp	LF356N or H (ALT 03-30074)	
IC5	03-30090	1	General Purpose JFET Op-Amp	LF356N or H (ALT 03-30074)	
IC6	03-30045	1	RMS to DC Converter	Analog Devices AD536ADJ or H	
IC7	03-30133	1	Quad general purpose comparator	LM339N	
IC8	03-30111	1	Precision chopper amplifier	Intersil ICL7650CPD or equiv.	03-303
IC9	03-30134	1	Dual very low noise Op-amp	NE5532N	
IC10	03-30090	1	General Purpose JFET Op-Amp	LF356N or H (ALT 03-30074)	
IC11	03-30036	1	Regulator,+15V,0.5A,T0202 or T0220	78M15CP or LM340T-15	
IC12	03-30037	1	Regulator,-15V,0.5A,T0202 or T0220	79M15CP or LM320T-15	
IC13	03-30144	1	Quad JFET switch	National LF1333N	
IC14	03-30144	1	Quad JFET switch	National LF1333N	
IC15	03-30106	1	BCD to 7-Segment decoder/driver	74LS47N	
IC16	03-30113	1	A to D Convertor (analog portion)	Intersil ICL8068ACPD or equiv.	
IC17	03-30114	1	A to D convertor (digital portion)	Intersil ICL71C03ACPI or equiv.	
IC18	03-30106	1	BCD to 7-Segment decoder/driver	74LS47N	
IC19	03-30113	1	A to D Convertor (analog portion)	Intersil ICL8068ACPD or equiv.	
IC20	03-30114	1	A to D convertor (digital portion)	Intersil ICL71C03ACPI or equiv.	
IC21	05-02007	1	Programmable Osc.,8.3Hz-1MHz	Statek,PX01000KHzA	
R8	01-50028	1	50K Top adjust	Beckman 68WR50K	
R9	01-01047	1	2.4K 5% 1/4W Carbon Film	RC07GF242J	
R10	01-01061	1	10K 5% 1/4W Carbon Film	RC07GF103J	
R11	01-01061	1	10K 5% 1/4W Carbon Film	RC07GF103J	
R12	01-01047	1	2.4K 5% 1/4W Carbon Film	RC07GF242J	
R13	01-01085	1	200K 5% 1/4W Carbon Film	RC07GF204J	
R14	01-01054	1	5.1K 5% 1/4W Carbon Film	RC07GF512J	
R15	01-10049	1	100K 0.1% 50ppm/C 1/4W Metal Film	RN60C1003B	
R16	01-10049	1	100K 0.1% 50ppm/C 1/4W Metal Film	RN60C1003B	
R17	01-10049	1	100K 0.1% 50ppm/C 1/4W Metal Film	RN60C1003B	
R18	01-10049	1	100K 0.1% 50ppm/C 1/4W Metal Film	RN60C1003B	
R19	01-10049	1	100K 0.1% 50ppm/C 1/4W Metal Film	RN60C1003B	
R20	01-10049	1	100K 0.1% 50ppm/C 1/4W Metal Film	RN60C1003B	
R21	01-10049	1	100K 0.1% 50ppm/C 1/4W Metal Film	RN60C1003B	
R22	01-01073	1	47K 5% 1/4W Carbon Film	RC07GF473J	
R23	01-01073	1	47K 5% 1/4W Carbon Film	RC07GF473J	
R24	01-01083	1	150K 5% 1/4W Carbon Film	RC07GF154J	
R25	01-01083	1	150K 5% 1/4W Carbon Film	RC07GF154J	
R26	01-01041	1	1K 5% 1/4W Carbon Film	RC07GF102J	

REF.DES.	STOCK #	QUANTITY			DESCRIPTION	MANUFACTURING/PURCHASING DATA	ALTERNAT
		A	T	N			
R27	01-01041	1			1K 5% 1/4W Carbon Film	RC07GF102J	
R28	01-50028	1			50K Top adjust	Beckman 68WR50K	
R29	01-50028	1			50K Top adjust	Beckman 68WR50K	
R30	01-10049	1			100K 0.1% 50ppm/C 1/4W Metal Film	RN60C1003B	
R31	01-10140	1			768 1% 50ppm/C 1/4W Metal Film	RN60C7680F	
R32	01-50033	1			50 Top adjust	Beckman 68WR50ohm	
R33	01-10131	1			750 1% 50ppm/C 1/4W Metal Film	RN60C7500F	
R34	01-50033	1			50 Top adjust	Beckman 68WR50ohm	
R35	01-10066	1			1.5K 1% 50ppm/C 1/4 Metal Film	RN60C1501F	
R38	01-10150	1			68.1K 1% 50ppm/C 1/4W Metal Film	RN60C6812F	
R39	01-50012	1			10K Top adjust	Beckman 68WR10K	
R40	01-01100	1			1M 5% 1/4W Carbon Film	RC07GF105J	
R41	01-01041	1			1K 5% 1/4W Carbon Film	RC07GF102J	
R42	01-01081	1			100K 5% 1/4W Carbon Film	RC07GF104J	
R43	01-50028	1			50K Top adjust	Beckman 68WR50K	
R44	01-10099	1			10.2K 1% 50ppm/C 1/4W Metal Film	RN60C1022F	
R45	01-50037	1			200 Top adjust	Beckman 68WR200ohm	
R46	01-10083	1			2.49K 1% 50ppm/C 1/4W Metal Film	RN60C2491F	
R48	01-10127	1			806 1% 50ppm/C 1/4W Metal Film	RN60C8060F	
R49	01-50033	1			50 Top adjust	Beckman 68WR50ohm	
R50	01-10133	1			845 1% 50ppm/C 1/4W Metal Film	RN60C8450F	
R51	01-10028	1			24.9K 1% 50ppm/C 1/4W Metal Film	RN60C2492F	
R52	01-50033	1			50 Top adjust	Beckman 68WR50ohm	
R53	01-10001	1			1.0K 1% 50ppm/C 1/4W Metal Film	RN60C1001F	
R54	01-01021	1			100 5% 1/4W Carbon Film	RC07GF101J	
R55	01-01047	1			2.4K 5% 1/4W Carbon Film	RC07GF242J	
R56	01-01061	1			10K 5% 1/4W Carbon Film	RC07GF103J	
R57	01-01061	1			10K 5% 1/4W Carbon Film	RC07GF103J	
R58	01-01047	1			2.4K 5% 1/4W Carbon Film	RC07GF242J	
R59	01-01085	1			200K 5% 1/4W Carbon Film	RC07GF204J	
R60	01-01054	1			5.1K 5% 1/4W Carbon Film	RC07GF512J	
R62	01-50033	1			50 Top adjust	Beckman 68WR50ohm	
R63	01-10008	1			10K 1% 50ppm/C 1/4W Metal Film	RN60C1002F	
R64	01-01061	1			10K 5% 1/4W Carbon Film	RC07GF103J	
R65	01-50029	1			500 Top adjust	Beckman 68WR500ohm	
R66	01-10015	1			243K 1% 50ppm/C 1/4W Metal Film	RN60C2433F	
R67	01-01061	1			10K 5% 1/4W Carbon Film	RC07GF103J	
R68	01-10008	1			10K 1% 50ppm/C 1/4W Metal Film	RN60C1002F	
R69	01-50029	1			500 Top adjust	Beckman 68WR500ohm	
R70	01-10015	1			243K 1% 50ppm/C 1/4W Metal Film	RN60C2433F	
R71	01-50028	1			50K Top adjust	Beckman 68WR50K	
R72	01-01040	1			910 5% 1/4W Carbon Film	RC07GF911J	
R73	01-01102	1			1.5M 5% 1/4W Carbon Film	RC07GF155J	
R74	01-50033	1			50 Top adjust	Beckman 68WR50ohm	
R75	01-10001	1			1.0K 1% 50ppm/C 1/4W Metal Film	RN60C1001F	
R76	01-10017	1			9.09K 1% 50ppm/C 1/4W Metal Film	RN60C9091F	
R77	01-01123	1			20M 5% 1/4W Carbon Film	RC07GF206J	
R78	01-01041	1			1K 5% 1/4W Carbon Film	RC07GF102J	
R79	01-01041	1			1K 5% 1/4W Carbon Film	RC07GF102J	
R80	01-01041	1			1K 5% 1/4W Carbon Film	RC07GF102J	
R81	01-01041	1			1K 5% 1/4W Carbon Film	RC07GF102J	

REF.DES.	STOCK #	QUANTITY	----- DESCRIPTION -----	----- MANUFACTURING/PURCHASING DATA -----	ALTER
		A T N			
R82	01-01040	1	910 5% 1/4W Carbon Film	RC07GF911J	
R83	01-50028	1	50K Top adjust	Beckman 68WR50K	
R84	01-10001	1	1.0K 1% 50ppm/C 1/4W Metal Film	RN60C1001F	
R85	01-50033	1	50 Top adjust	Beckman 68WR50ohm	
R86	01-10017	1	9.09K 1% 50ppm/C 1/4W Metal Film	RN60C9091F	
R87	01-01021	1	100 5% 1/4W Carbon Film	RC07GF101J	
R88	01-01086	1	220K 5% 1/4W Carbon Film	RC07GF224J	
R89	01-01041	1	1K 5% 1/4W Carbon Film	RC07GF102J	
R90	01-01041	1	1K 5% 1/4W Carbon Film	RC07GF102J	
R91	01-01021	1	100 5% 1/4W Carbon Film	RC07GF101J	
R92	01-01053	1	4.7K 5% 1/4W Carbon Film	RC07GF472J	
R93	01-01073	1	47K 5% 1/4W Carbon Film	RC07GF473J	
R94	01-01061	1	10K 5% 1/4W Carbon Film	RC07GF103J	
R95	01-01085	1	200K 5% 1/4W Carbon Film	RC07GF204J	
R96	01-01070	1	33K 5% 1/4W Carbon Film	RC07GF333J	
R97	01-01086	1	220K 5% 1/4W Carbon Film	RC07GF224J	
R98	01-10143	1	453 1% 50ppm/C 1/4W Metal Film	RN60C4530F	
R99	01-10085	1	249 1% 50ppm/C 1/4W Metal Film	RN60C2490F	
RN1	01-40002	1	8 x 100 Network	A-B 316B-101	
RN2	01-40002	1	8 x 100 Network	A-B 316B-101	
R100	01-50014	1	100 Top adjust	Beckman 68WR100ohm	
R101	01-10078	1	2K 1% 50ppm/C 1/4W Metal Film	RN60C2001F	
R102	01-01073	1	47K 5% 1/4W Carbon Film	RC07GF473J	
R103	01-01061	1	10K 5% 1/4W Carbon Film	RC07GF103J	
R104	01-01085	1	200K 5% 1/4W Carbon Film	RC07GF204J	
R105	01-01070	1	33K 5% 1/4W Carbon Film	RC07GF333J	
R106	01-01086	1	220K 5% 1/4W Carbon Film	RC07GF224J	
R107	01-50014	1	100 Top adjust	Beckman 68WR100ohm	
R108	01-10078	1	2K 1% 50ppm/C 1/4W Metal Film	RN60C2001F	
R117	01-50028	1	50K Top adjust	Beckman 68WR50K	
R118	01-01093	1	470K 5% 1/4W Carbon Film	RC07GF474J	
R119	01-10085	1	249 1% 50ppm/C 1/4W Metal Film	RN60C2490F	
S1	05-03003	1	Switch, DPDT, Push-Push, Red knob	Centralab 004184	
S2	05-03058	1	Switch, 8Sta., Interlocked	Centralab	
TP1	05-10290	1	Test hook, pcb	Vector K32-2	
TR1	03-10013	1	NPN Transistor (T092)	2N4401	
TR2	03-10013	1	NPN Transistor (T092)	2N4401	
TR3	03-10013	1	NPN Transistor (T092)	2N4401	
TR4	03-10013	1	NPN Transistor (T092)	2N4401	
TR5	03-10013	1	NPN Transistor (T092)	2N4401	
TR6	03-10010	1	PNP Transistor (T092)	2N4402	
TR7	03-10013	1	NPN Transistor (T092)	2N4401	
TR8	03-10013	1	NPN Transistor (T092)	2N4401	
TR9	03-10013	1	NPN Transistor (T092)	2N4401	
TR10	03-10013	1	NPN Transistor (T092)	2N4401	
TR11	03-10013	1	NPN Transistor (T092)	2N4401	
TR12	03-10013	1	NPN Transistor (T092)	2N4401	
TR13	03-10013	1	NPN Transistor (T092)	2N4401	
XIC15	05-10008	1	Socket, dil, 16 pin	Burndy C8516-01	
XIC16	05-10041	1	Socket, dil, 14 pin	Burndy 8514-01	
XIC17	05-10295	1	Socket, dil, 28 pin	Burndy D1LB28P-108	

REF.	DES.	STOCK #	QUANTITY	DESCRIPTION	MANUFACTURING/PURCHASING DATA	ALTERNAT
			A T N			
XIC18		05-10008	1	Socket, dil, 16 pin	Burndy C8516-01	
XIC19		05-10041	1	Socket, dil, 14 pin	Burndy 8514-01	
XIC20		05-10295	1	Socket, dil, 28 pin	Burndy DILB28P-108	

REF.DES.	STOCK #	QUANTITY			DESCRIPTION	MANUFACTURING/PURCHASING DATA	ALTER
		A	T	N			
2	04-30071	1			Display Board	DWG 2100-701	
DS1	05-01011	1			LED,Red,Panel Mount		
DS2	05-01011	1			LED,Red,Panel Mount		
DS3	05-01020	1			Display,LED,Red,+/-1	Hewlett Packard,QDSP-3789 Bin B	
DS4	05-01010	1			Display,LED,Red,0-9	Hewlett Packard,5082-7650-S02	
DS5	05-01010	1			Display,LED,Red,0-9	Hewlett Packard,5082-7650-S02	
DS6	05-01010	1			Display,LED,Red,0-9	Hewlett Packard,5082-7650-S02	
DS7	05-01010	1			Display,LED,Red,0-9	Hewlett Packard,5082-7650-S02	
DS8	05-01020	1			Display,LED,Red,+/-1	Hewlett Packard,QDSP-3789 Bin B	
DS9	05-01010	1			Display,LED,Red,0-9	Hewlett Packard,5082-7650-S02	
DS10	05-01010	1			Display,LED,Red,0-9	Hewlett Packard,5082-7650-S02	
DS11	05-01010	1			Display,LED,Red,0-9	Hewlett Packard,5082-7650-S02	
DS12	05-01010	1			Display,LED,Red,0-9	Hewlett Packard,5082-7650-S02	

SECTION VII SCHEMATIC DIAGRAMS

The following schematics are included with this manual:

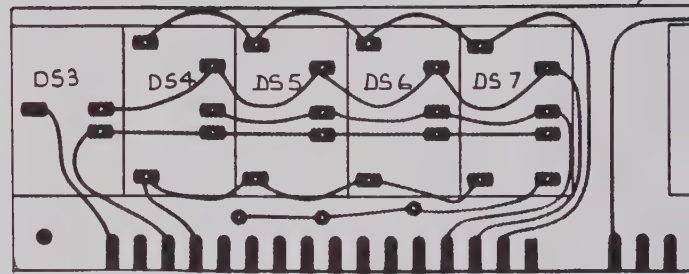
Diagram No.	Description	Pages
2100-070	Schem. Dig. Watt.	2
2100-400	Rear Panel Assy.	1
2100-400	Assembly	1
2100-601	Main Bd. Assy.	1
2100-601	Display Bd Assy.	1

D

C

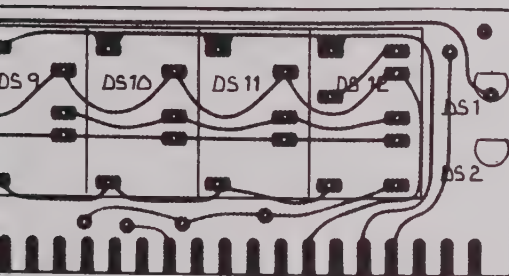
B

A



CLAD SHOWN IS

- DISPLAY BOARD



**Valhalla
Scientific Inc.**
SAN DIEGO, CA

DISPLAY BOARD ASSY. 2100/2101

CODE IDENT	SIZE	DRAWING NO	REV
53504	C	2100-601	B

D

C

A

2100-601

B

A

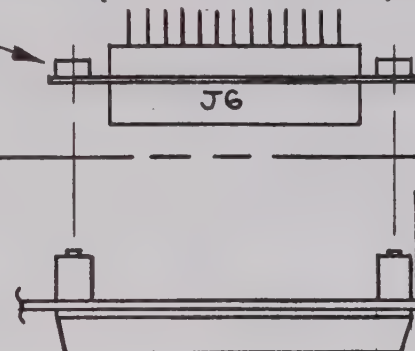
SEE PARTS LIST 2100-405 {
 (MOUNT CONNECTOR WITH PINS 1 THRU 13 UP)

SCREW 4-40

CONNECTOR 25PIN
 (MOUNT CONNECTOR WITH PINS 1 THRU 13 UP)

(OPTION "DMX" ONLY)

J6



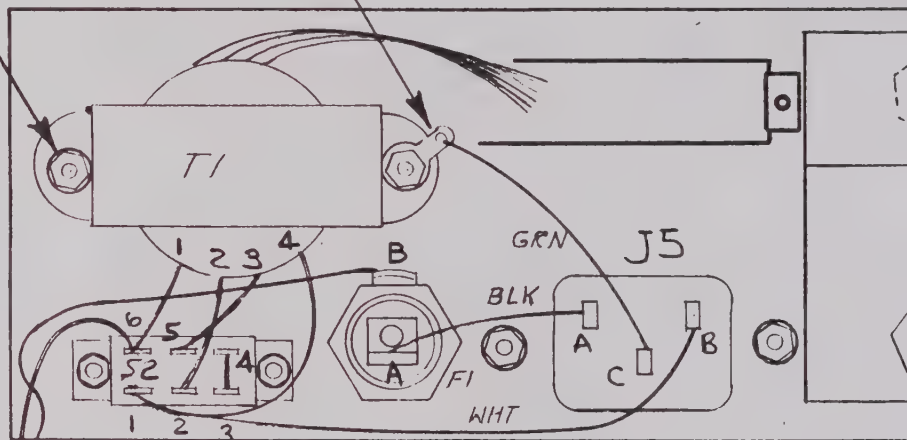
30 HOLE PLUG

5 PL {
 18 6-32
 19 WASHER
 20 NUT

NUT 20
 SOLDER LUG 23
 SCREW 6-32 18

WG

BL BR



TWISTED PAIR
 TO S1 ON PCB
 (12")

WHT BLK

E6 E7

ON PCB
 2100-700

BINDING
 POST
 2 PL

SHIELD

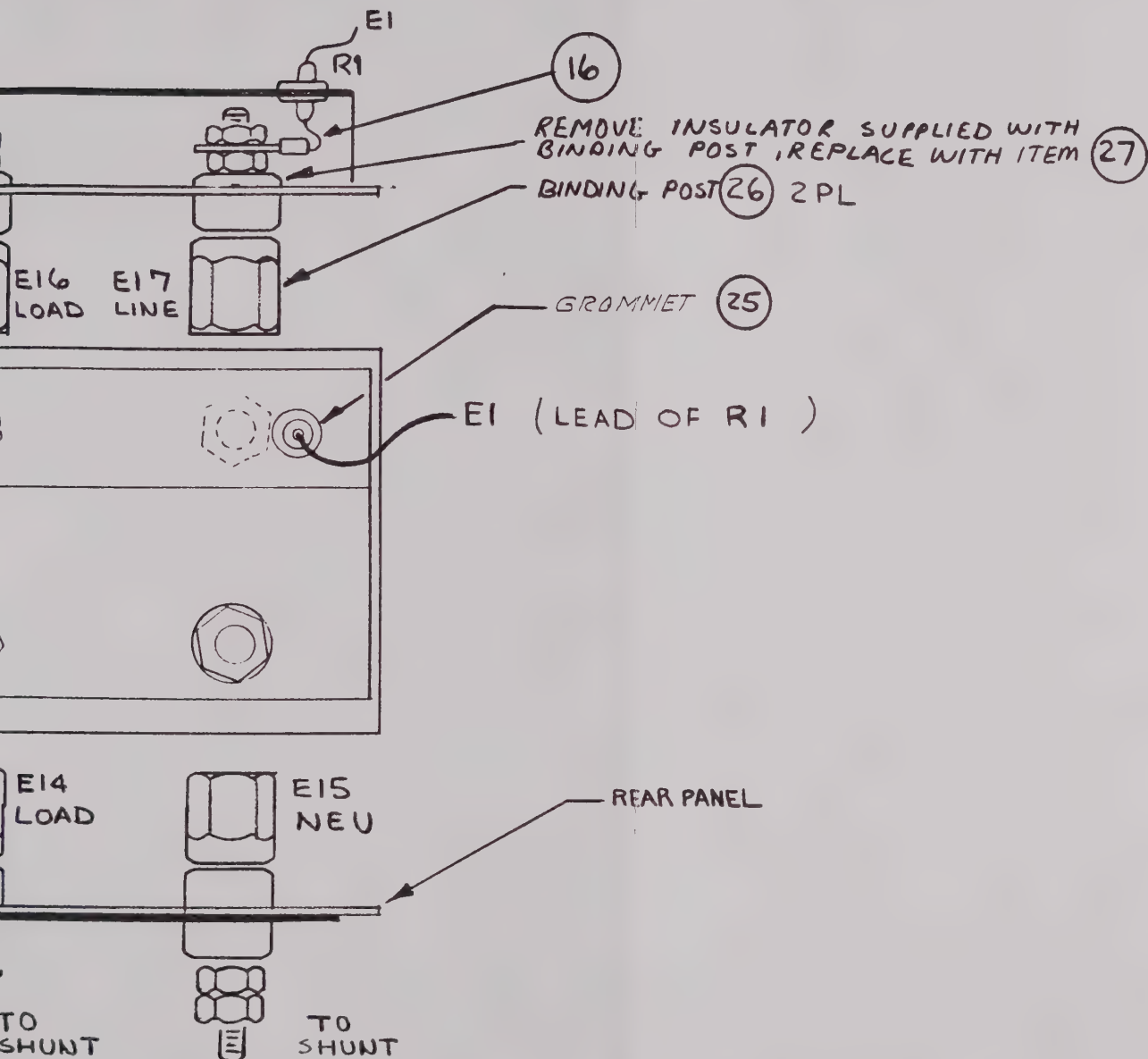
#8 WASHER

TO E2

TRANSF. LEADS

1. WHT/BLK
2. WHT
3. BLK/WHT
4. BLK

36



Valhalla Scientific Inc.

SAN DIEGO, CALIFORNIA

REAR PANEL ASSEMBLY DWG.

CODE IDENT NO.	SIZE	DRAWING NO.	REV.
53504	B	2100-400	0

D

C

B

A

TP1

INSTALL TEST HOOK
IN PIN 1 OF IC6
DIP OUTLINE

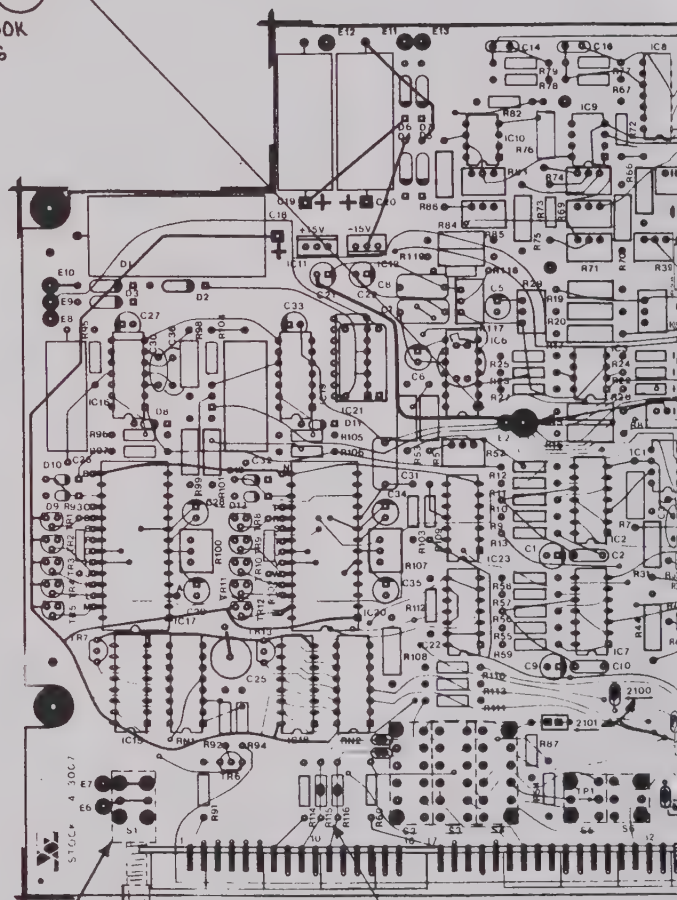
INSTALL SPACERS
ON CORNER PINS
OF SWITCHES (16 PL)

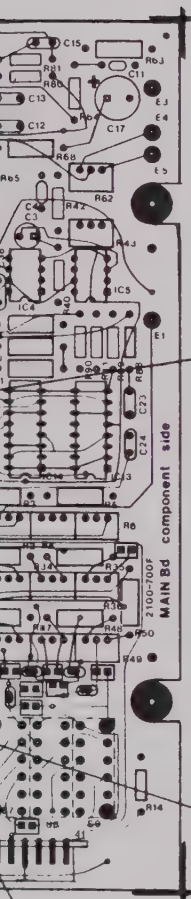
S1-S9 ARE MOUNTED ON THE
FAR SIDE OF THE BOARD.

FOR 2100 USE SOLDER
FOR 2101 USE RI15

93

SILVER BUTTONS
SUPPLIED WITH SWITCH
9 PL.





100 TERMINAL

FOR 2100 SOLDER BRIDGES MARKED 12 PL.
FOR 2101 SOLDER BRIDGES MARKED 11 PL.

3 DISPLAY BD. ASSY.



**Valhalla
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SAN DIEGO, CA

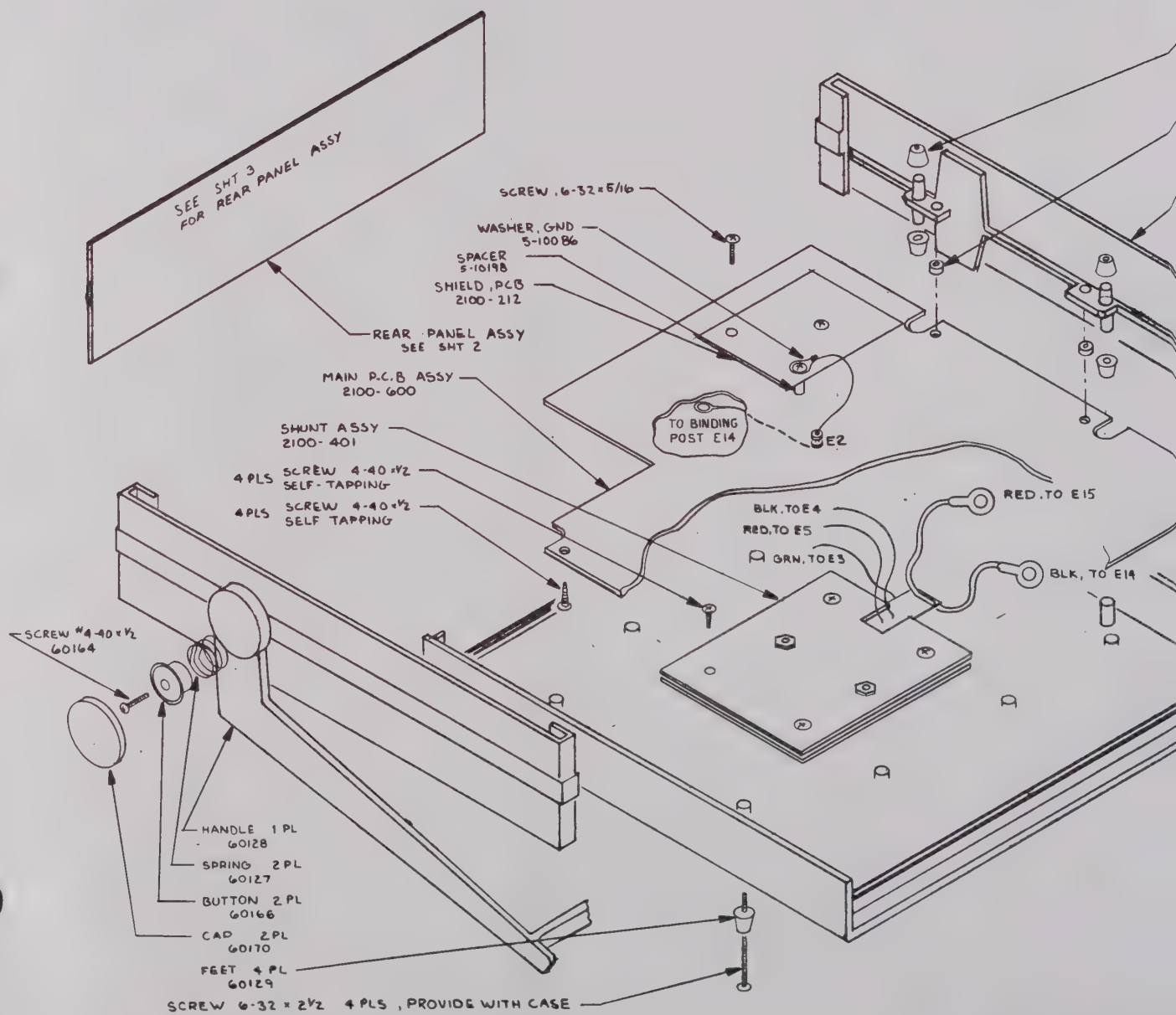
2100 - 2101 MAIN BD. ASSY.			
CODE IDENT	SIZE	DRAWING NO	REV
53504	C	2100-600	V

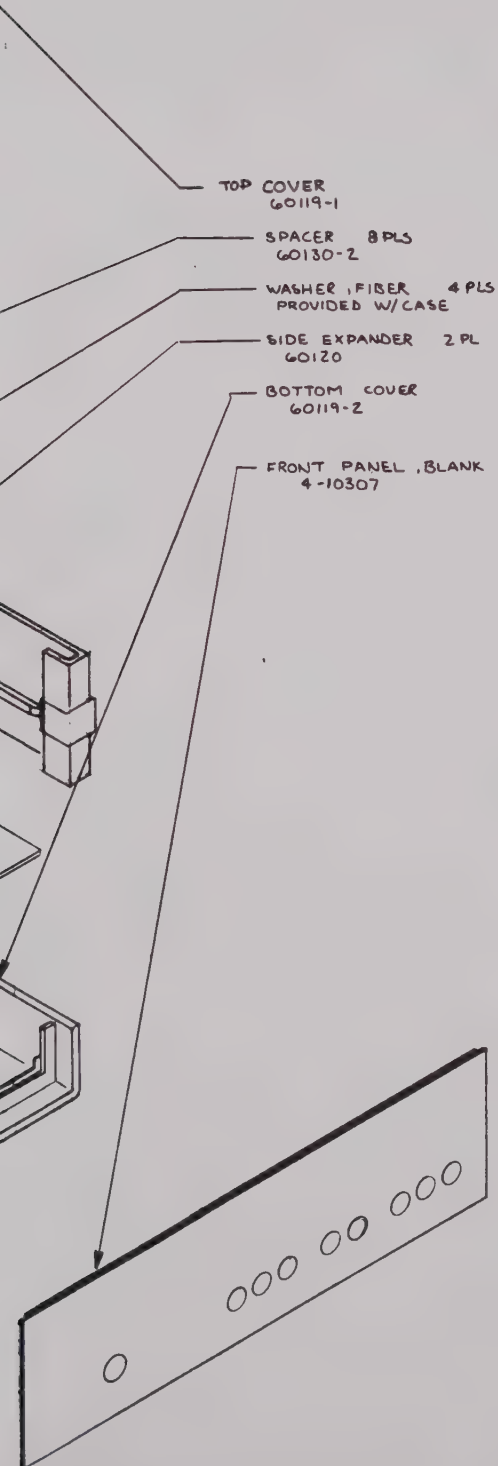
D
C
B
A

C

B

A





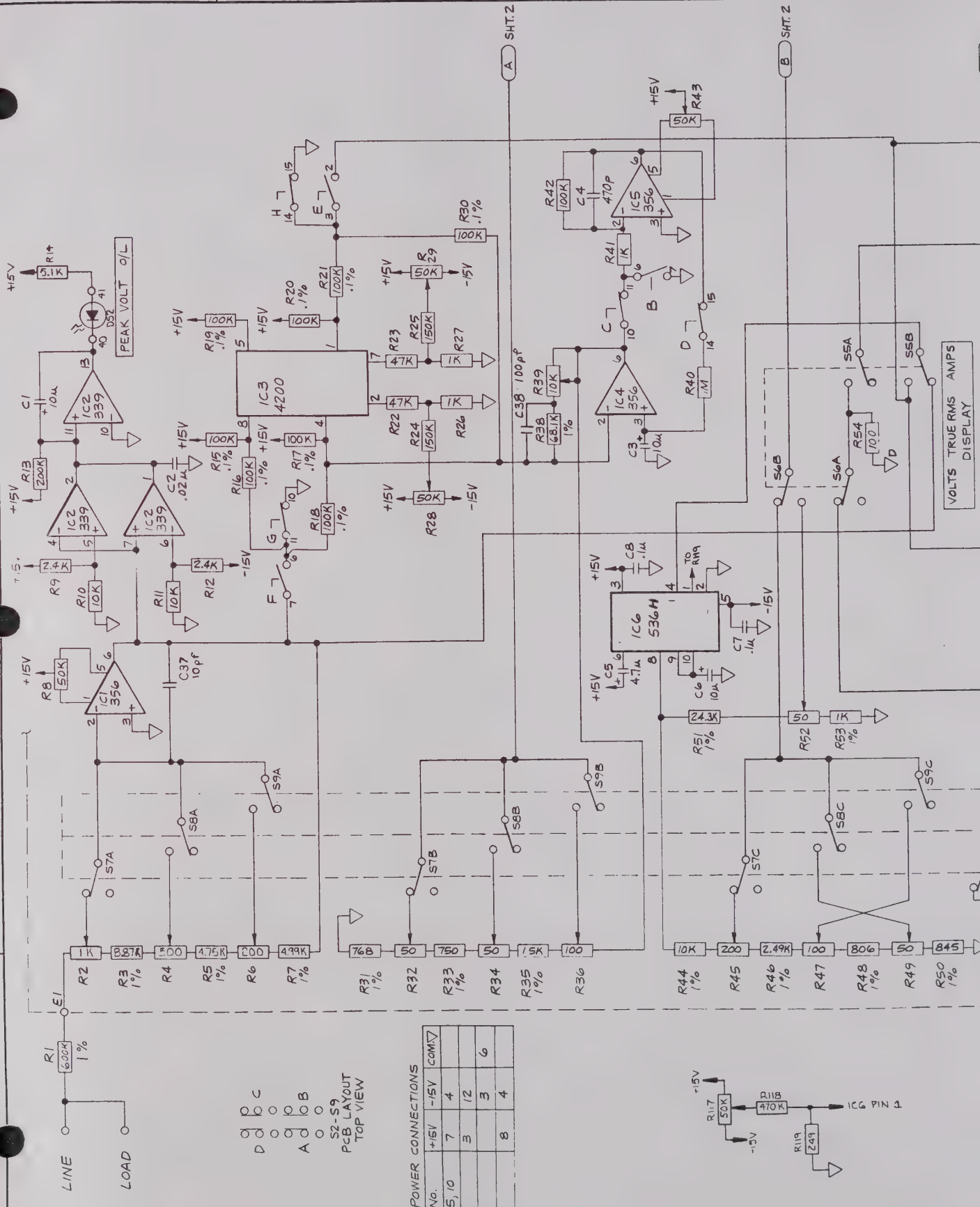
NOTES:

1. FOR SCHEMATIC SEE 2100-070 SHTS 1 AND 2.
2. FOR PARTS LIST SEE SHTS 1 AND 2 OF 2100-400
3. FOR FINAL PARTS PLACEMENT ON 2100 SEE
4. FOR FINAL PARTS PLACEMENT ON 2101 SEE 2100-404.

Valhalla Scientific Inc.
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ASSEMBLY -
MODEL 2100 / 2101

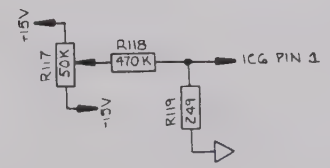
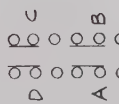
CODE IDENT NO	REV	DRAWING NO	REV
53504	D	2100-400	0

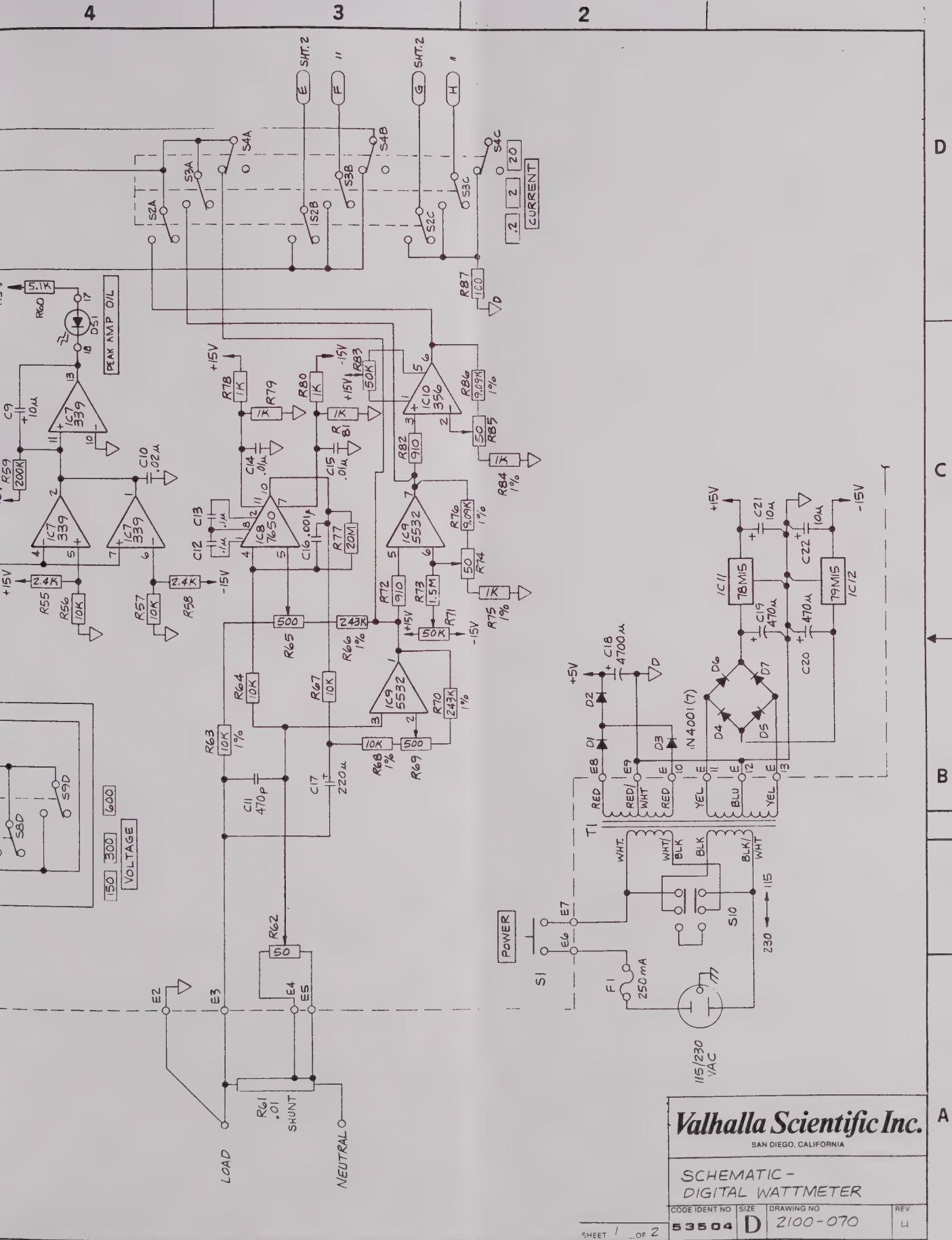


POWER CONNECTIONS

IC No.	+15V	-15V	COM
1, 4, 5, 10	7	4	
2, 7	3	12	6
3		3	
9	8	4	

S2-S9
PCB LAYOUT
TOP VIEW

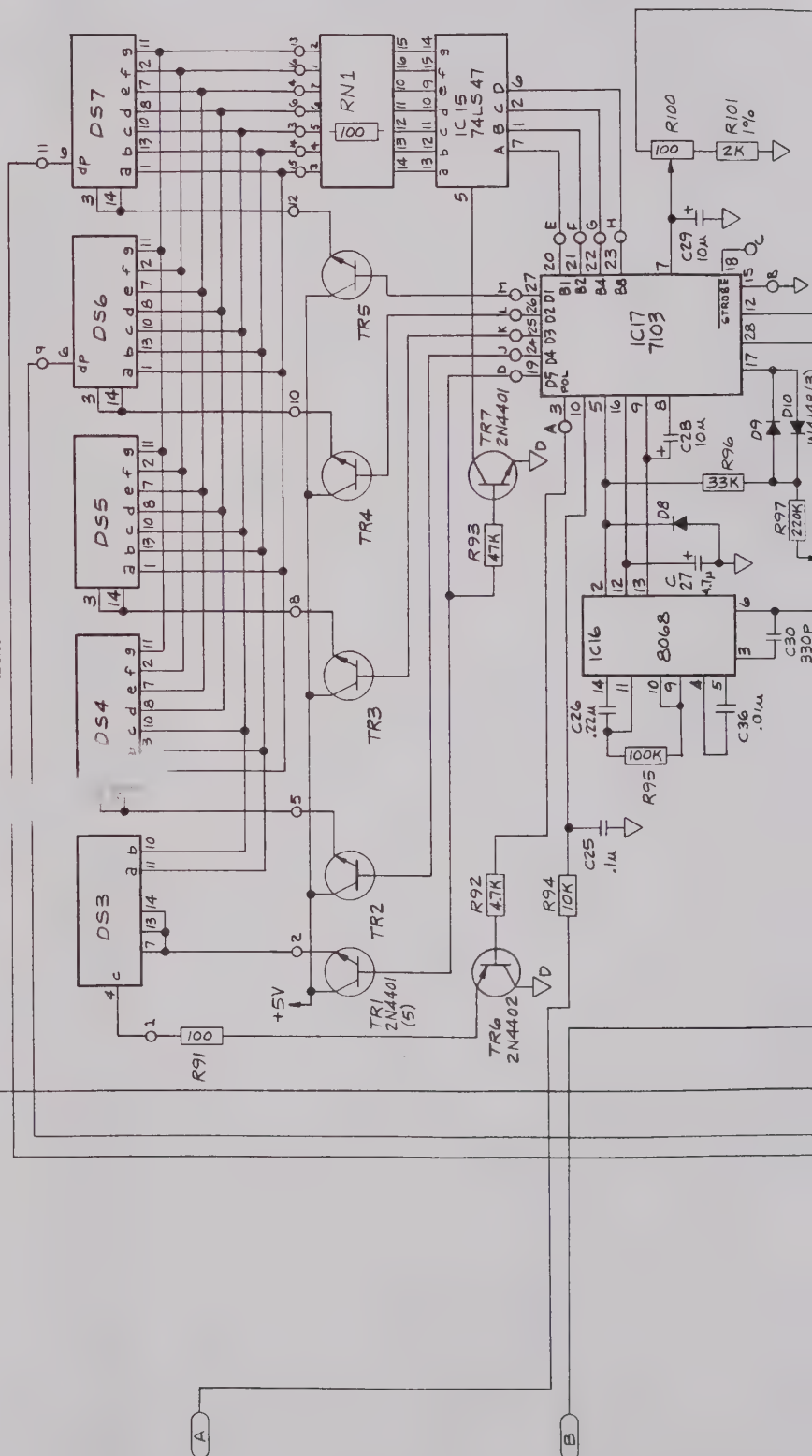
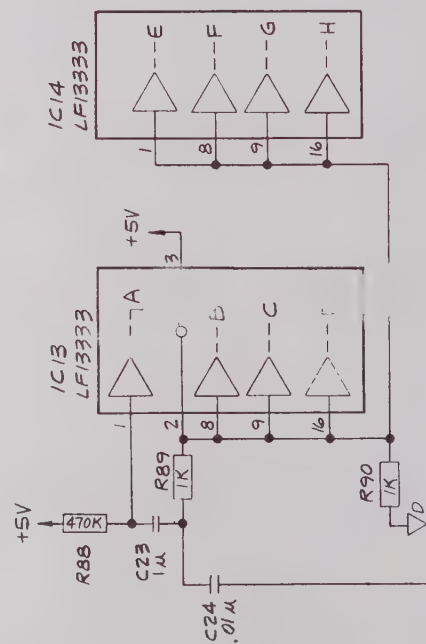




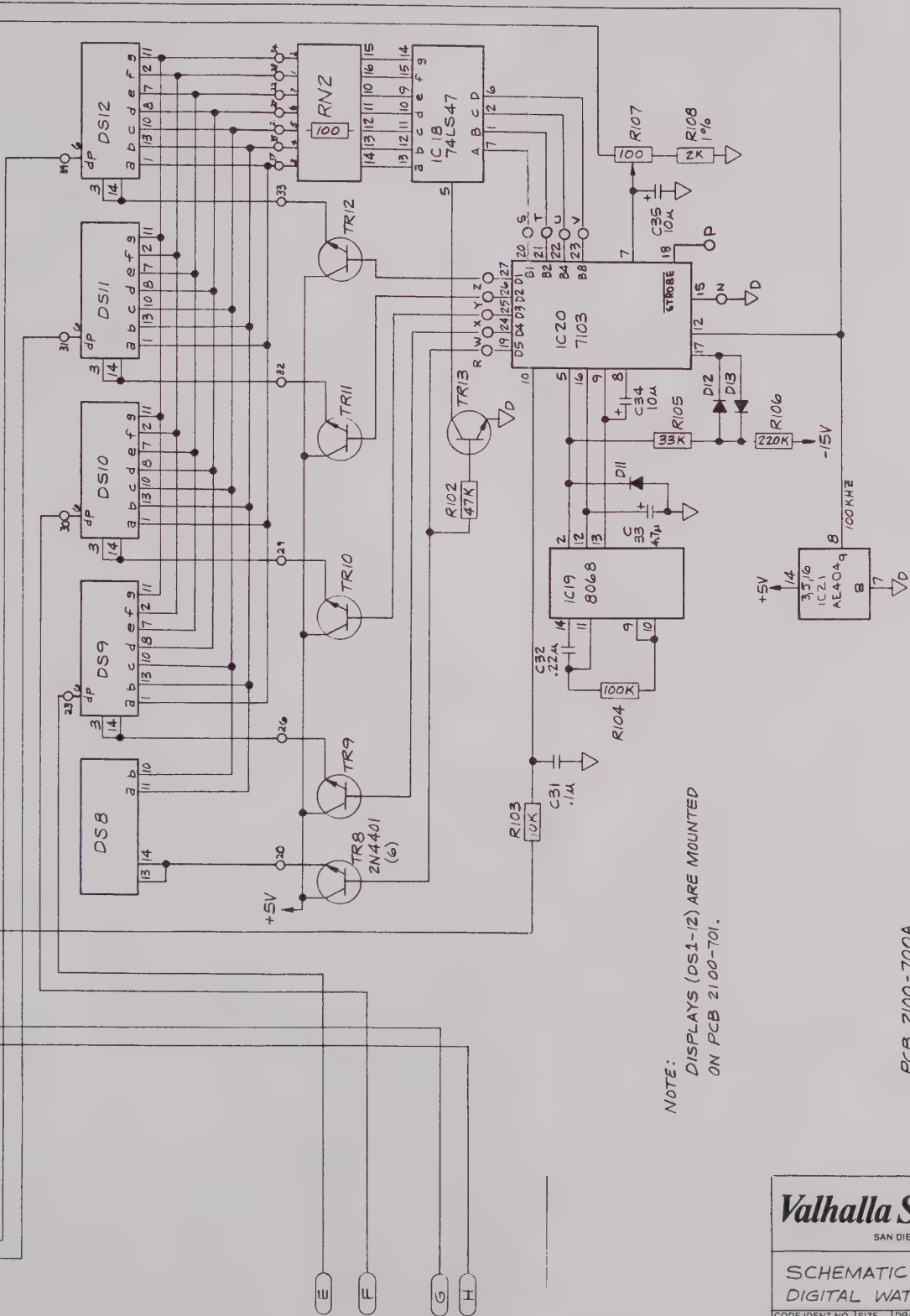
POWER CONNECTIONS

IC No.	+15V	-15V	▽	+5V	▽b
13,14	12	5	4		
15,18				16,3	8
16	7,8	1	5		
19	8	1	5		
17,20		6	11	1	15

WATTS-TRUE POWER



AMPS TRMS - VOLTS TRMS



NOTE:
DISPLAYS (DS1-12) ARE MOUNTED
ON PCB 2100-701.

PCB 2100-700A

Valhalla Scientific Inc.
SAN DIEGO, CALIFORNIA

SCHEMATIC -
DIGITAL WATTMETER

CODE IDENT NO 53504	SIZE D	DRAWING NO 2100-070	REV I
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ADDENDUM

2100 Series with 1020A

Effective Date: January 20, 1998

Subject: Use of Models 2100 and 2101 with optional 1020A Remote Interface Module

Applicability: Models 2100 and 2101 fitted with special data output capability (DMX-1020), using the Model 1020A Isolated Remote Interface Module.

Content:

This document is provided to describe operation of the 1020A Interface Module for data acquisition from the Model 2100 and 2101 Digital Power Analyzers. Modified Power Analyzers may be connected to the Interface Module to provide remote data acquisition via a serial RS232C and/or a GPIB (IEEE-488.2) port. Also available is a Centronics-compatible parallel printer output. The various ports are available in any combination. Note that the 1020A module may be used for remote data acquisition only, and not for range or mode control of the Power Analyzer.

1. Installation and Connections

1.1 Power Analyzer-to-1020A Interface Module Connections

A ribbon cable (provided) must be connected between the Power Analyzer and the 1020A. Connect this cable from the Power Analyzer "DATA OUTPUT" port to the 1020A port labeled "1020A INPUT". This cable carries range and numeric information from the Power Analyzer. Connections may now be made to any desired port on the back of the 1020A, according to the type of interface that will be used (see sections 1.2 thru 1.4).

Note: Before applying power to the 1020A, ensure that the rear-panel switch has been set to the correct local AC line voltage. Also check that the correct fuse for this voltage has been installed. Fuse values are listed on the rear of the 1020A.

Upon application of power, all indicators will illuminate for several seconds as the 1020A performs its internal self-check routine. When the PRINT and/or REMOTE indicators are extinguished, the 1020A is ready for use.

1.2 Connecting to the Serial Bus (Option RS232)



Connections to the serial interface are made to the port labeled "RS232C INTERFACE" and require a female DB9-pin connector, in conjunction with a null-modem cable. The RS232C port is configured as data terminal equipment (DTE) therefore a null-modem cable or adaptor is required to interface to other DTE equipment such as computers and terminals. A "null-modem" cable or adapter reverses the roles of various data and control signals to make a DTE device appear as a DCE device or vice-versa. These items are not provided but are available at most computer outlets.

Knowledge of the specific pin functions of Valhalla's serial connector may be necessary for certain applications. The connector is numbered inside the housing, next to the pins. The function of each pin is described below.

Pin #1: not used	Pin #6: Data Set Ready (DSR)
Pin #2: Receive Data (RXDI)	Pin #7: not used
Pin #3: Transmit Data (TXDO)	Pin #8: Clear To Send (CTS)
Pin #4: Data Terminal Ready (DTR)	Pin #9: not used
Pin #5: Signal Ground ($\perp$)	

1.3 Connecting to the IEEE-488 Bus (Option IEEE)

Connections to the IEEE-488 interface require a standard 488 interface cable, also known as a GPIB cable. The cable may be a maximum of 2 meters in length, and should be shielded. These standard cables are available from most computer supply outlets or from Valhalla Scientific as Options GP-1 (1 meter) and GP-2 (2 meter). The GPIB cable is connected to the port on the rear of the 1020A labeled "GPIB INTERFACE".

All items in the bus are connected in parallel, or "daisy-chained" so that all devices receive the same set of signals. The bus consists of an 8-bit data bus (DIO1-DIO8); 3 handshake lines (DAV, NRFD, NDAC); and 5 control lines (IFC, ATN, SRQ, REN, EOI)

1.4 Connecting to the Parallel Printer Port (Option PAR)

Connections to the printer interface are made using a male DB25-pin connector at the port on the rear of the 1020A labeled "PARALLEL PRINTER". The other end of the cable should be a Centronics-compatible parallel printer connector. This item is not provided but should have been supplied with the printer you are using. This standard cable is also available at most computer outlets.

2. RS232C Serial Operations



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(

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This section describes operational notes which apply only to the serial interface of the 1020A. If you are not using the serial interface, you may skip this section.

Data may be exchanged with the 1020A using the following protocol:

Baud Rate:	9600	Stop Bits:	1
Parity:	none	Handshake:	no
Word width:	8		

Rules for sending commands:

- 1) The ECHO feature *must* be set either ON or OFF immediately following power-up or reset. It is set ON by sending a _ (carriage return or Enter), or OFF by sending a space. If the 1020A receives any other character before a _ or a space, it will enter a lock-out mode and require a reset via the power switch, or by sending a tilde character (~).
- 2) The last character of each command sent via the serial bus *must* be a semi-colon (;). The 1020A will not decode a command until receipt of a semi-colon, therefore all commands listed in Section 5 must have a ; added after the last character.
- 3) When operating via the serial bus, the REMOTE indicator on the front of the 1020A will flash briefly whenever data is data is being exchanged with the controller.

In addition to the commands listed in the Command Set of Section 5, the 1020A serial port recognizes an ECHO command to control its echo mode.

ECHO : Turn Echo Feature On or Off

Syntax : ECHO ➤state◀;

Where:

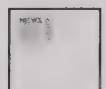
➤state◀ is 1 for ON, or 0 for OFF

When using the RS232C port via a PC, the echo will be cumbersome in half-duplex mode and should be shut off using this command, or by a reset and sending a space.

(Space=ECHO OFF; _=ECHO ON)

3. GPIB (IEEE-488) Operations

This section describes operational notes which apply only to the GPIB (IEEE-488.2) interface of the 1020A. If you are not using this interface, you may skip this section.



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The 1020A GPIB interface has been designed to comply with the IEEE 488.1 and 488.2 interfacing standards. A complete description as to the workings and requirements of this standard is beyond the scope of this addendum. Interested users should refer to any of several publications on the subject:

- a) Tutorial Description of the Hewlett-Packard Interface Bus (HP part number 5021-1927)
- b) ANSI/IEEE Standards 488.1 and 488.2-1987

Due to the fact that all items on the bus are connected in parallel, a system had to be designed to tell them apart. The "address" of a device is the method by which the system controller (computer or other device) is able to differentiate one instrument from another.

The 1020A has been set at the factory for operation at address "18". If this address will not work within the constraints of your system, follow the steps below which describe setting the 1020A's IEEE address.

- 1) Unplug the device from the AC line and remove all connections from the rear panel.
- 2) Remove the four screws in the bottom cover. The top cover may now be lifted up and off.
- 3) The address is determined by the setting of an 8-position DIP switch. Lift the front panel slightly to reveal this switch. Note: The address switch (located behind the front panel) should not be confused with the interface configuration switch "S2" located on the left side of the board. If S2 is accidentally changed, restore switches #6 and #8 only to the *up* position.
- 4) The table below gives the coding used to determine the address. The switch is numbered directly below each position of the switch. A flashlight may be necessary to read this numbering. Note that switches are selected by placing them in the *open* or *up* position.

Table 1. Address Switch (S1) Coding								
S1 Marking	1	2	3	4	5	6	7	8
Binary Code	closed	closed	closed	16	8	4	2	1

The address switch uses a standard "8-4-2-1" binary code. For the default setting of "18", switches #4 and #7 were selected (opened) because $16 + 2 = 18$. To set the address to 25, for example, switches #4, #5 and #8 would be selected because $16 + 8 + 1 = 25$.

Note that the switch coding allows selection of any address from 0 to 31. Certain addresses such as 0 and 31 may not be allowed in your system due to dedicated use by the system controller, disk-drive, printer, or other peripheral device. When selecting a new address, note that all devices on the bus must have their own unique address. Operating two devices at the same address will produce undefined results and is *not* recommended.

- 5) After setting the address switch to its new position, replace the front panel, side panels and top cover. Note: Use great care not to pinch any of the internal wiring between the covers. Replace the four feet screws in the bottom cover.



- 6) Restore all connections to the 1020A and apply AC power. The interface is now ready for use. Note that each time the address is changed, power must be cycled to place the new value into memory.

The General-Purpose Interface Bus (GPIB) method of remote communication allows several instruments to be connected to the same line using a system of "addressed commands". For example to communicate with the Valhalla 1020A operating at address 18, the system controller first sends a universal message telling all devices on the bus, *except the one at address 18*, to ignore the following information until an end-of-command signal is received. After the end of the command has been detected, all devices resume listening for their address. In effect, only the device at address 18 received the data and responded accordingly.

The command set (see Section 5) consists of a group of instructions that are recognized by a specific device. These instructions consist of universal commands (those which are recognized by all devices as specified by IEEE-488.2), and device-specific commands which are recognized only by a certain manufacturer or model number. The commands may further be divided into *standard commands* which do not require that a result be returned over the bus, or *queries* which always provide a result. Most of the commands used by the Valhalla ohmmeter are universal commands and queries.

Some commands are single words, but others consist of a root command followed by one or more variables, also called arguments. Arguments may be used to set multiple parameters such as the time and date information required by the command that is used to set the internal clock. For commands with multiple arguments such as TRIG and SETCLK, the root command must be separated from the first argument by a space.

Before devices may respond to data on the bus, they must have their remote function enabled. This is done by activating the REM (for remote) line on the bus. The REM line is enabled for all devices on the bus by executing a **REMOTE 7** command in HP Basic, or by selecting remote in other systems. An addressed version of the statement, **REMOTE 718**, places only the device at address 18 into remote mode. The 1020A illuminates its REMOTE indicator when remote operation is enabled. Placing the 1020A into remote mode does not affect the operation of the Model 2100 or 2101 Power Analyzer that may be connected to it.

The following sample program, given in HP Basic, describes the use of a query command. If you are using a language or software package other than HP Basic, consult the appropriate literature for the correct command syntax.

10	REMOTE 718	enables the device at address 18 to respond to instructions
20	DIM A\$[100]	dimensions the variable A\$ so that it may contain up to 100 characters
30	OUTPUT 718;"*IDN?"	this query is a universal command which asks that the device identify itself
40	WAIT .1	a delay of 100ms is recommended following issuance of a query
50	ENTER 718;A\$	asks the device for the result of the query, and assigns it to the variable A\$
60	PRINT A\$	displays the result
70	END	signals the end of the program

The result of this program is the display of the identification string for the 1020A which is:



Other commands in the command set may substituted for the *IDN? query above. If the command is not a query, the ENTER and PRINT statements should not be used. The 1020A command set is given in Section 5.

Note that all commands *must* be terminated with a _ (line-feed). Most new 488.2 compatible controllers automatically add a _ to terminate a command. Some older controllers such as pre-488.2 Hewlett Packard Basic systems may require the programmer to add a _ to the command line. A _ is ASCII character 10. Therefore, in HP Basic a _ would be added to line 30 of the sample program as shown below:

```
30 OUTPUT 718;"*IDN?";CHR$(10)
```

A delay of 100ms is recommended following issuance of a query before soliciting a response. Also note that a 5 second delay will be encountered following a power-up or reset before the 1020A may respond over the bus.

In addition to the commands listed in Section 5, the 1020A also recognizes all commands that are required by the IEEE-488.2 standard. The "*CLS" command (given below) is a GPIB command that may be used to clear the output buffer of any undesired data. This may be necessary in a situation in which a response to a query has not been read. In this case, no further queries would be accepted until the previous one has been read. The *CLS command clears this response so that other inquiries may be made.

***CLS : Clear the Status Registers**

Syntax: *CLS

Definition: This command clears any data from the buffers and any response bytes. It may be used clear unwanted responses to queries.

4. Printer Operations

The 1020A is available with a Centronics-compatible parallel printer interface. Measurements displayed on the Power Analyzer may be sent to a printer by pressing the PRINT button on the front of the 1020A. A green LED indicates data transfer. This direct print-out method does not require an external computer or other controller.

Further details not yet available.

5. Command Set for Both IEEE-488 and RS232C Interfaces



This section contains the user interface commands that are recognized by the 1020A. Commands may be sent via the IEEE-488 and/or RS232C ports. Refer to the preceding sections for details regarding communication with either of these ports.

Responses to measurement queries are returned in scientific notation including five significant digits and an exponent (power of 10). For example, a WATTS? response of 1.2345e+2 would represent 1.2345×10^2 , or 123.45 watts. The rate at which measurements are updated is restricted by the conversion rate of the Power Analyzer which is 1¼ readings per second.

AMPS? : Amperes Measurement Query

Syntax: AMPS?

Definition: This query may be used to return the amperes measurement. Values are returned in amps. Note that the Power Analyzer must have AMPS selected for display. If the amperes reading is not available, the 1020A returns the value: "-1.0000e+0".

VOLTS? : Volts Measurement Query

Syntax: VOLTS?

Definition: This query may be used to return the volts measurement. Values are returned in volts. Note that the Power Analyzer must have VOLTS selected for display. If the voltage reading is not available, the 1020A returns the value: "-1.0000e+0".

WATTS? : Power Measurement Query

Syntax: WATTS?

Definition: This query may be used to return the power measurement. Values are returned in watts. See also the TRIG command.

TRIG : Send Timed Power Measurement Data to Serial or Printer

Syntax: TRIG >port<, >strttime<, >interval<, >readings<, >stamp<

Where:

>port< is the location of the destination port: SERIAL or PRINTER
>strttime< is the time to begin taking readings in the format HH:MM:SS or NOW to start immediately (24 hour format)



- interval< is the amount of time in whole seconds to wait between readings and must be greater than 0 and less than 84,600 (24hrs)
- readings< is the successive number of readings
- stamp< to send date/time stamp with reading, 1=yes, 0=no.

Definition: This command may be used as an alarm clock function to begin taking power measurements at a specified time, or to log readings at specified time intervals to a printer or serial device. To stop the program you may either reset the interface, cycle power, or send the command again with "1" reading.

☞ The query **TRIG** may be used by itself to simply retrieve a single power reading (it duplicates the WATTS? query). Allow a minimum 100ms delay following issuance of this shortened form before soliciting a response.

***IDN? : Identification Query**

Syntax: *IDN?

Definition: This query instructs the 1020A to return a preset identification message to the controller. Since the 1020A is a universal interface module and can be interchanged with multiple Power Analyzers, the "Serial#" field indicates the serial number of the module itself, not the serial number of the Power Analyzer.

Identification response format: VALHALLA SCIENTIFIC,1020A,Serial#,Firmware Version

***OPT? : Device Options**

Syntax: *OPT?

Definition: This query instructs the 1020A to return a message listing any optional equipment that has been fitted.

Response: "Option(s) : GPIB(IEEE488.2),PRINTER,RS232C"

***RST : Hardware Reset**

Syntax: *RST

Definition: The *RST command will reset all hardware parameters and bus functions to their default conditions. Note: A minimum 5 second delay must be allowed following issuance of this command. From the serial port only, a tilde character (~) will also cause a reset.

TIME? : Get the System Time



Syntax: TIME?

Definition: The Interface Module contains an internal real-time clock. This query instructs the module to return its present system time.

The TIME command returns a string in the format hh:mm:ss <day of week> <month> <date> <year>. For example, 06:45:15 Sunday May 2, 1993.

SETCLK : Set the Internal Clock

Syntax: SETCLK ➤hours<,>minutes<,>seconds<,>day<,>month<,>date<,>year<

Where:

➤hours<	is hours in 24-hr time, 0-23.
➤minutes<	is the minutes, 0-59.
➤seconds<	is the seconds, 0-59.
➤day<	Sun=1, Mon=2, Tue=3, Wed=4, Thu=5, Fri=6, Sat=7
➤month<	Jan=1, Feb=2, Mar=3, etc.
➤date<	is the numeric day of the month, 1-31
➤year<	is the year, 1992-9999.

Definition: This command is used to set the internal real-time clock.

End of Addendum #9407. ■

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